



Renewable Energy Efforts in California

Opportunities for Renewable Integration in Technology & Infrastructure

Dora Yen-Nakafuji

**California Tribal Training
January 24, 2008
Sacramento, CA**

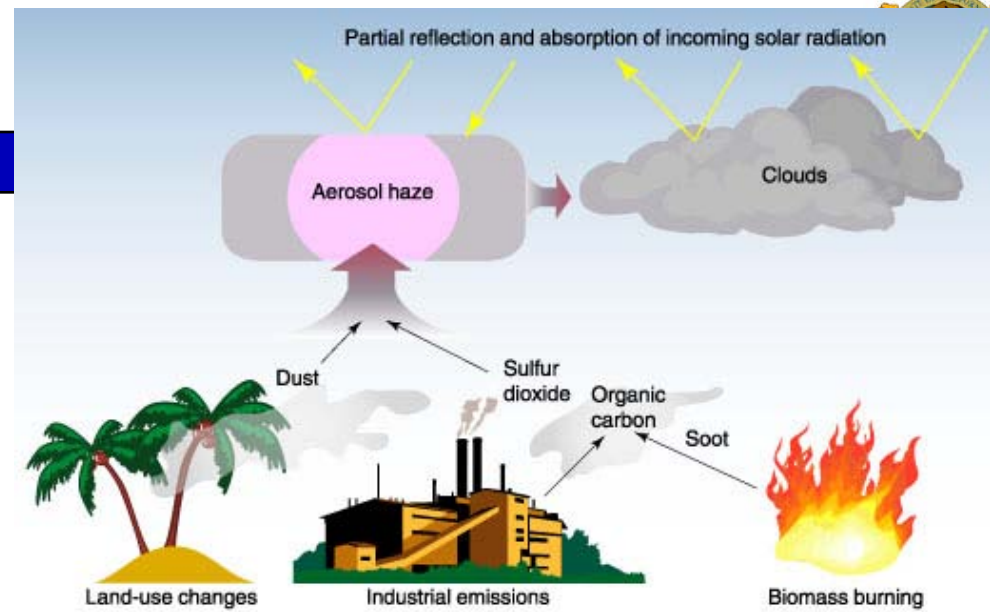


*RENEWABLE
ENERGY
PROGRAM*

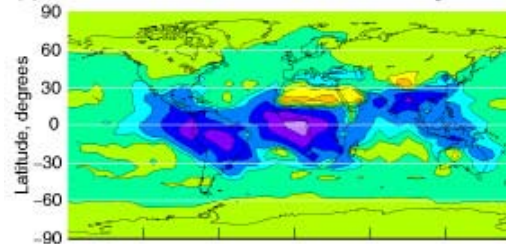
CALIFORNIA ENERGY COMMISSION



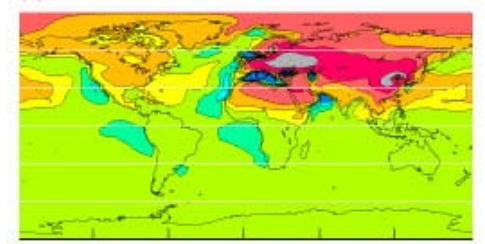
Global Warming



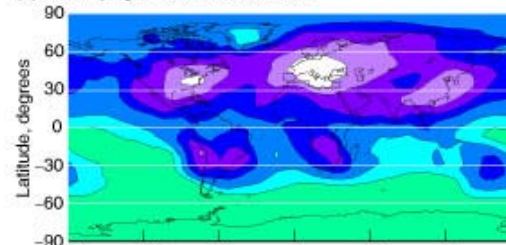
(a) Carbonaceous aerosols from biomass burning



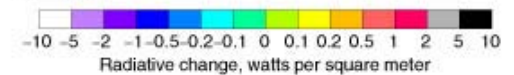
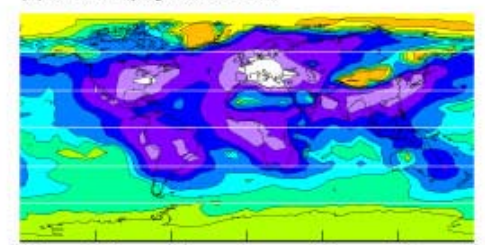
(b) Carbonaceous aerosols from fossil fuels



(c) Anthropogenic sulfate aerosols



(d) All anthropogenic aerosols

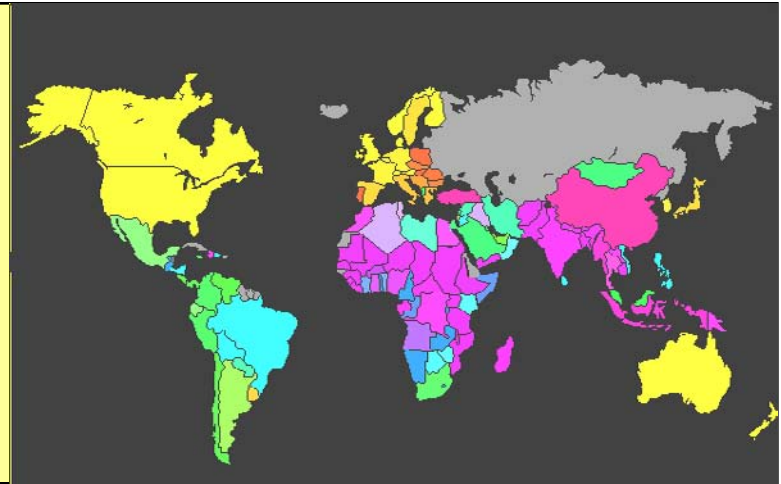


Is it really us?

World Perspective – We're not alone!



Governments throughout the world are focusing energy policy strategy to address the following goals:

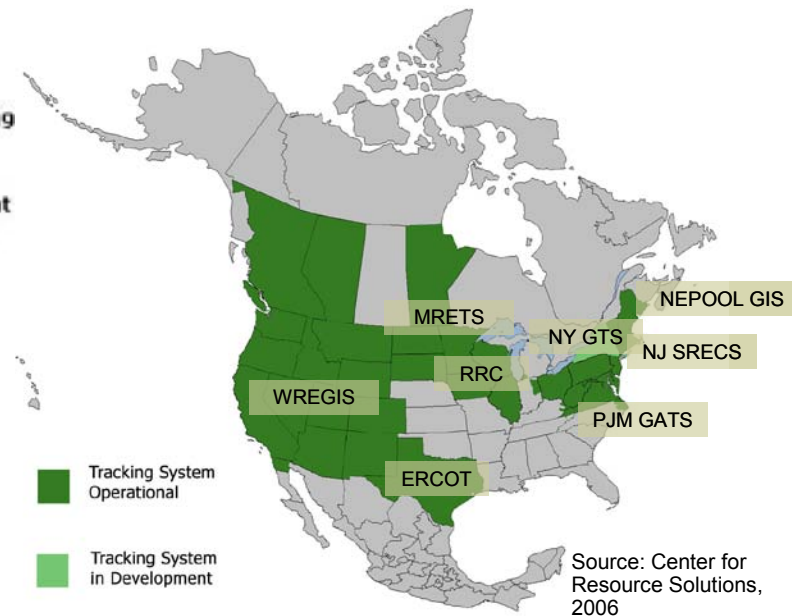
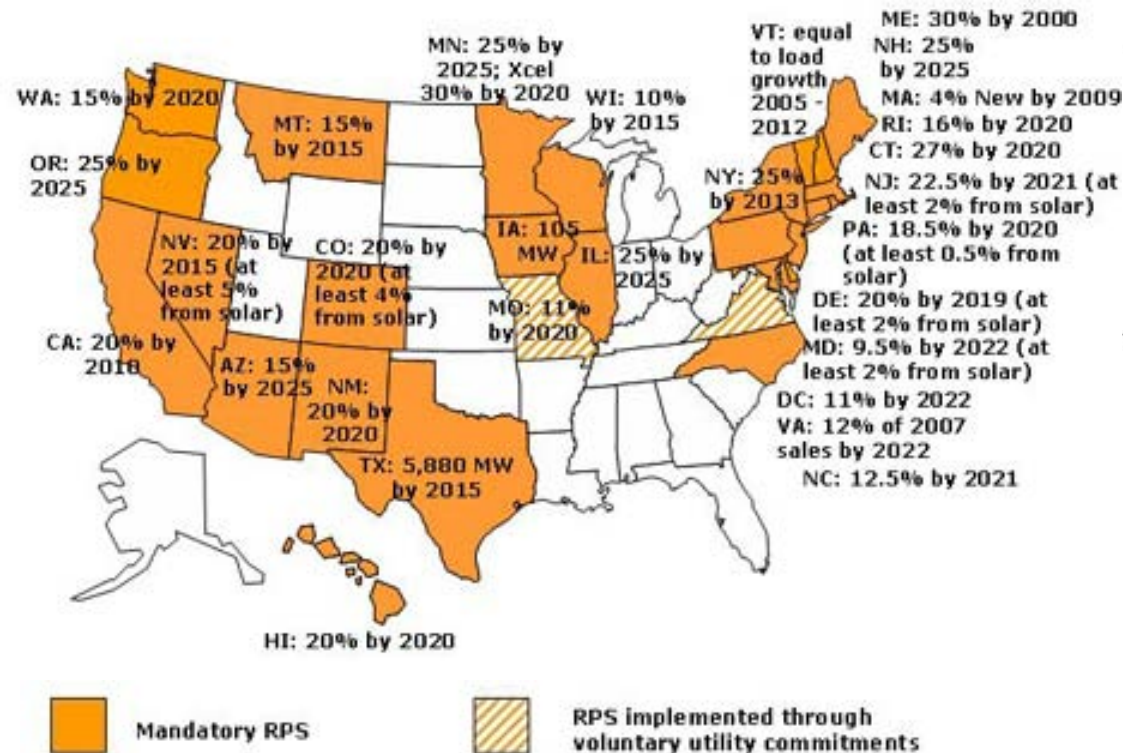


- Reduce and mitigate climate change impacts (pollution, GHG)
- Strengthen energy security by reducing dependence on oil
- Eliminate fuel poverty by diversifying with environmentally-friendly resources
- Support economic growth & competitiveness



RPS Nationwide

- 26+ states have mandatory RPS (portfolios mix of resources) & tracking
- Mainland states are addressing new renewable integration challenges
- Mainland states are interconnected regionally and share control authority
- Mainland states are members of NERC and share in the integration planning efforts

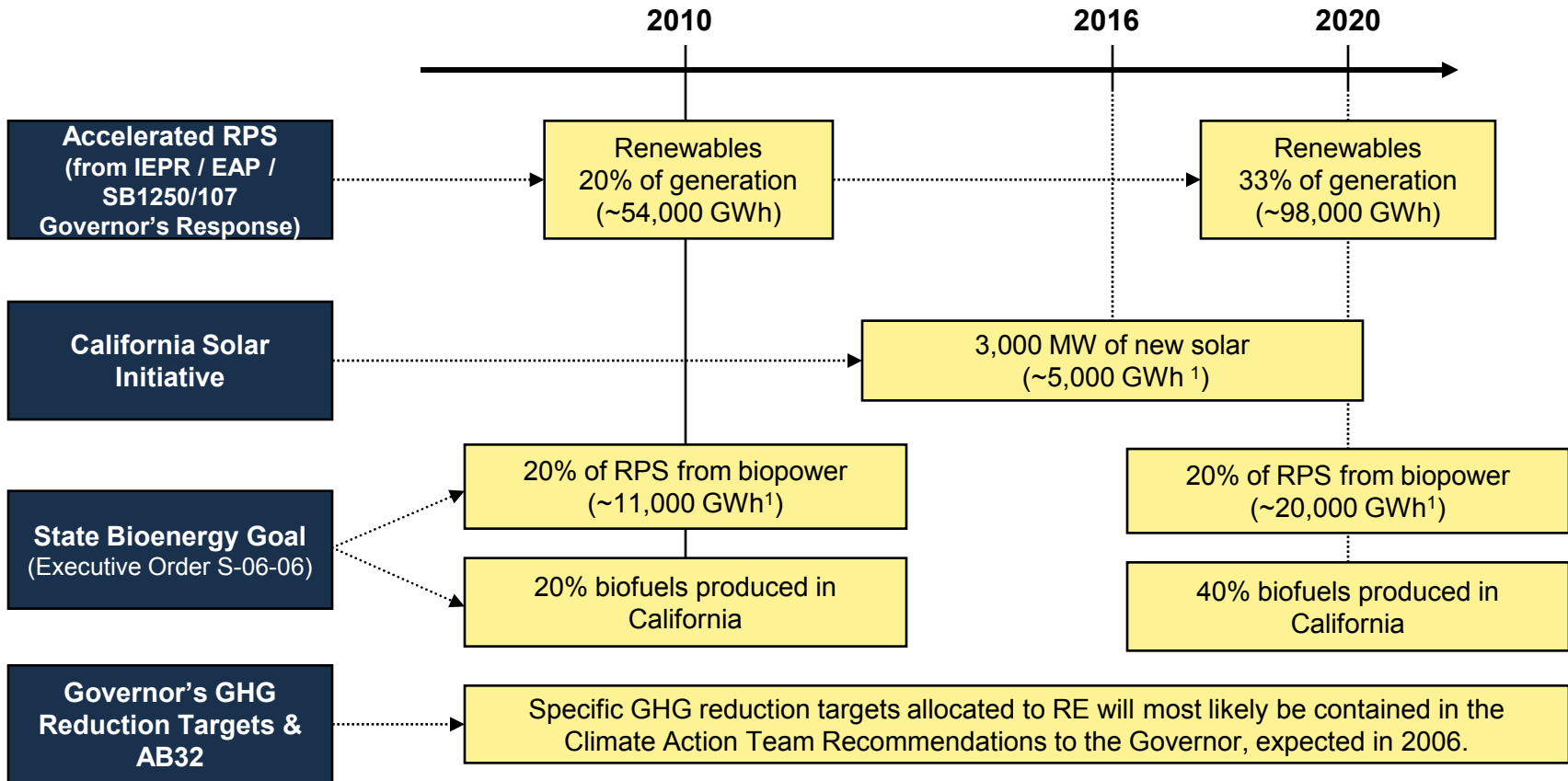


Attribute Tracking System for RPS - WREGIS

Key CA Renewable Energy Policies



Key Renewable Energy Policy Impacting California



1. Assumed average capacity factors are 20% for solar and 90% for biopower.
Note: The roadmap also considered detailed policy guidance as stated in the IEPR.



A Critical Question

How do we integrate a large amount of renewable energy sources into our way of life (onto the grid) without sacrificing reliability?

Facts of Life:

- **Mandated Renewable Portfolio Standard (wind, geothermal, biomass, etc)**
- **Wind, geothermal, biomass...resources have different generation characteristics**
- **Current power systems were not designed to operate with large amounts of differing and variable renewable resources**
- **When ANY resource is not carefully integrated (planned) onto the power system, the system will be more prone to failures**

Overview

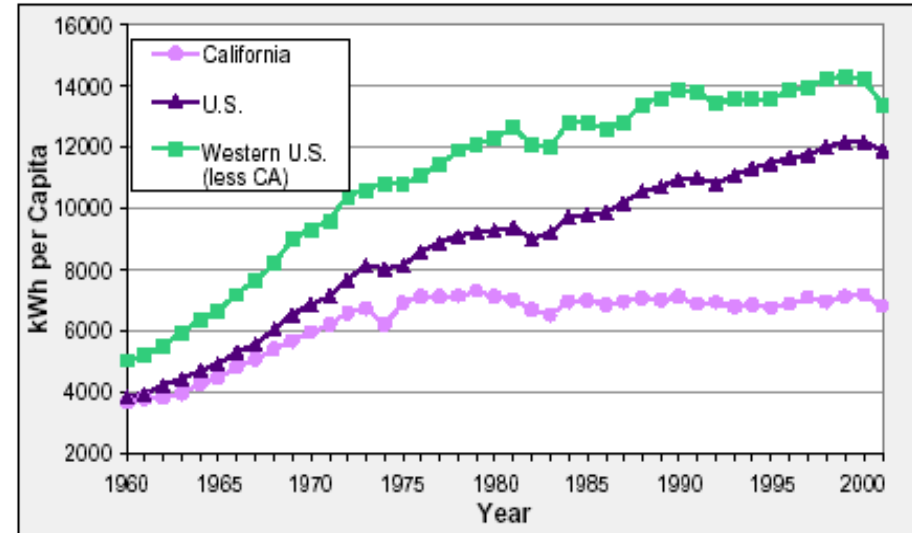


- RPS Policies and Roles in Perspective
- Challenges for CA to Integrate Renewables
- Putting it all Together – Integrated Planning
 - Near-term research efforts & options
 - Long-term sustainable future
 - Continuing efforts
- Points to Share

Background: Renewable Energy in California



- For decades, California led the country and the world in renewable energy procurement and energy efficiency standards
- From its peak in early 1990s, renewable generation declined amid market uncertainties
- In 1996, AB 1890 placed surcharge on electricity sold by IOUs to be used to fund public interest programs, including renewable energy
- Creation of California Energy Commission Programs
 - **Public Interest Energy Research (PIER)**, a program to support and conduct energy research, development and demonstration (RD&D) projects that will help improve the quality of life in California by bringing environmentally safe, affordable and reliable energy services and products to the marketplace (<http://www.energy.ca.gov/pier/>)
 - **Renewable Energy Program**, a subsidy mechanism to support renewable development in a market environment (<http://www.energy.ca.gov/renewables/>)
- 2002 Enactment of a statewide Renewable Portfolio Standard (RPS) to increase diversity, reliability, public health and environmental benefits of California's energy mix.



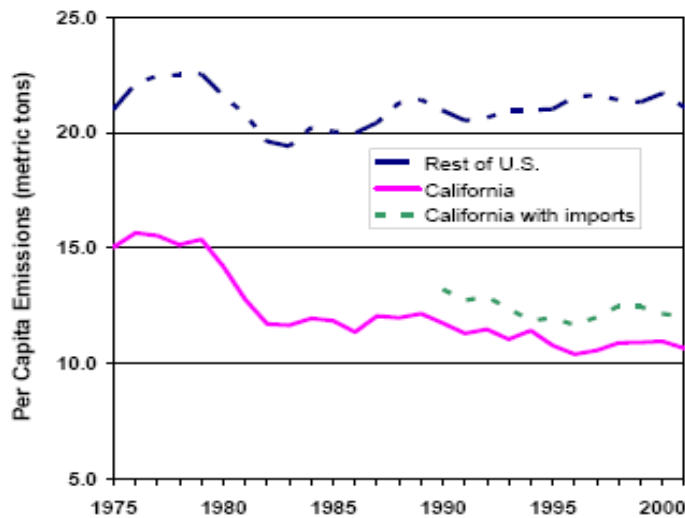
Californians use almost 50% less electricity than the U.S. average
Source: Energy Information Agency and California Energy Commission



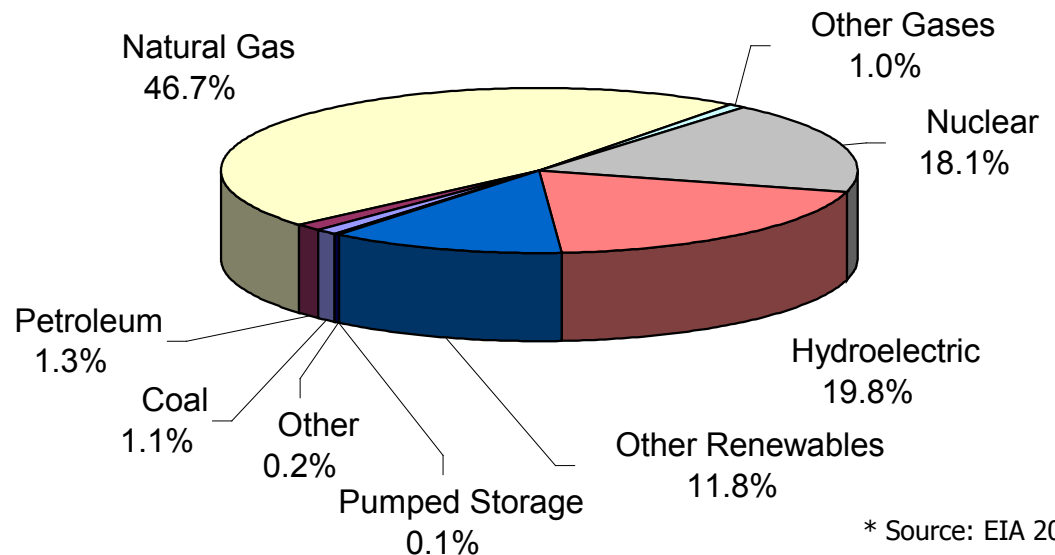
Today's California Energy Picture

- Diverse mix of renewable and conventional generation
- **Top 10 generation plants are gas, nuclear and hydro resources**
- Lead in energy efficiency and ranks 3rd in petroleum refining capacity
- **Primary resource is natural gas, 80% imported from other states & Canada**
- Nearly 25% of electricity consumed is imported from neighboring states over high voltage DC lines

Per Capita Carbon Dioxide Emissions



Source: Oak Ridge National Laboratory, 2004.⁴

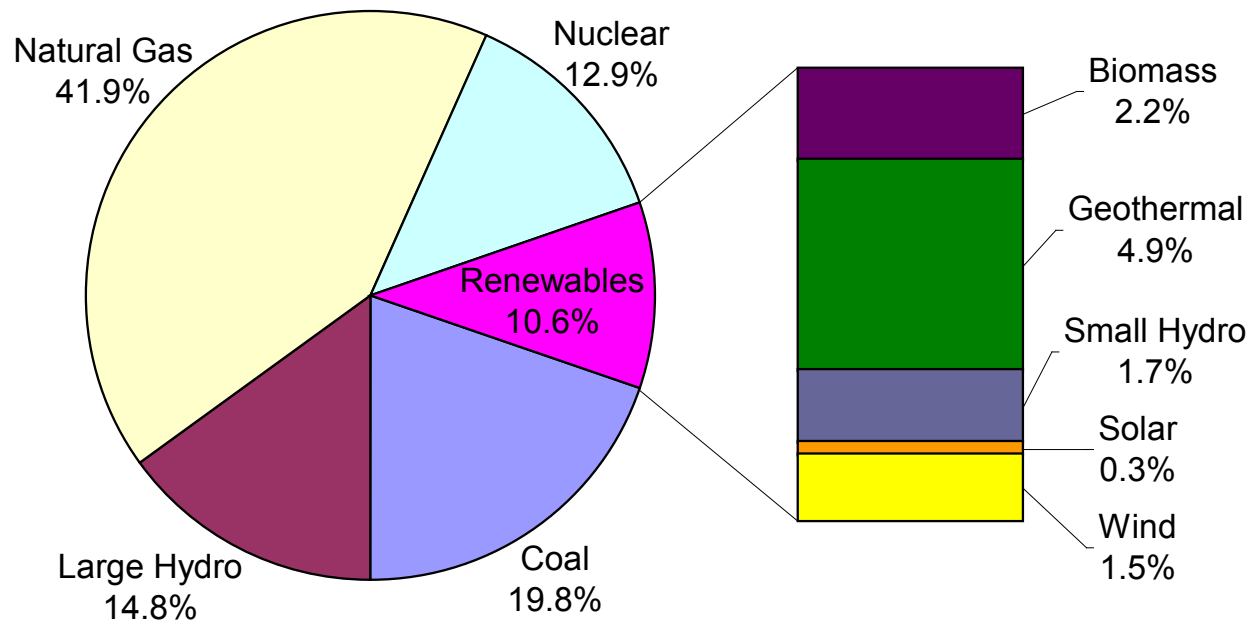
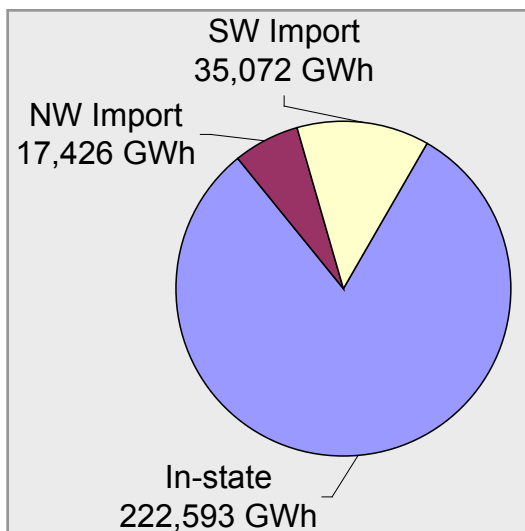


* Source: EIA 2005

California Electricity



Total Gross System Energy 275,091 GWh



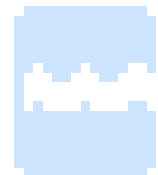
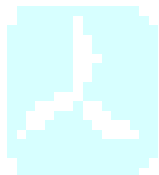
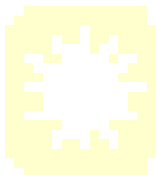
Most diverse portfolio of electrical generating resources

2004 Gross System Energy Source: CEC

RPS Eligible Technologies



- Biomass
- Biodiesel
- Conduit hydro
- Fuel cells using renewable fuel
- Digester gas
- Geothermal
- Landfill gas
- Municipal solid waste conversion
- Ocean wave, ocean thermal, tidal current
- Photovoltaic
- Small hydro
- Solar thermal electric
- Wind





IOU RPS Contracts by Technology

	PG&E	SCE	SDG&E	Total
Wind	531	2,019 – 2,387	357	2,907 – 3,275
Biogas	9 – 99	8 – 9	24	41 – 132
Biomass	105 – 125	44 – 69	84	232 – 277
Geothermal	435 – 570	335 – 545	20	790 – 1,135
Ocean	2	0	0	2
Small Hydropower	1	0	5	6
Solar Thermal	731	500 – 850	399 – 999	1,629 – 2,579
Solar Photovoltaic	7	8 – 22	0	15 – 29
TOTAL (MW)	1,820 – 2,065	2,914 – 3,882	887 – 1,487	5,622 – 7,434

Source: California Energy Commission, Database of IOU Contracts for Renewable Generation, January 14, 2008, update, www.energy.ca.gov/portfolio/IOU_CONTRACT_DATABASE.XLS. Totals may not sum due to rounding.

Roles and Collaborations



CEC ROLE

- Certify renewable facilities as eligible for the RPS.
- Design and implement accounting system to track and verify RPS compliance.
- Distribute Supplemental Energy Payments (SB 1036 deletes CEC authority to award SEPs and transfers administrative responsibility to CPUC)

CPUC ROLE

- Oversight of IOU procurement:
 - Approve procurement plans.
 - Set baselines and targets.
 - Develop market price referent.
 - Develop least-cost-best-fit process to evaluate bids.
 - Set rules for flexible compliance.
 - Standardize contract terms.
 - Approve/ reject contracts.
 - Ensure RPS competitiveness.
- Oversight for other “retail sellers.”

Roles of Others ?

California RPS Projections

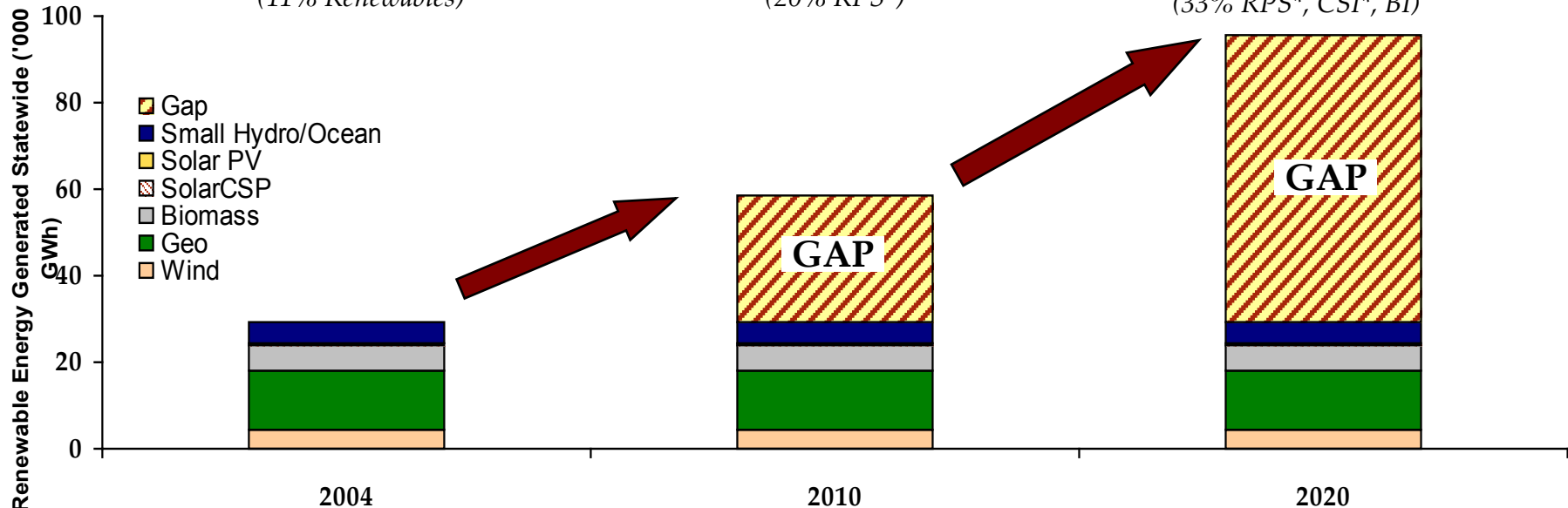


Projected Renewables to Meet California Policy Goals

Total: 29,000 GWh
(11% Renewables)

2010 Tot: ~ 59,000 GWh
(20% RPS*)

2020 Tot: ~ 99,000 GWh
(33% RPS*, CSI*, BI)



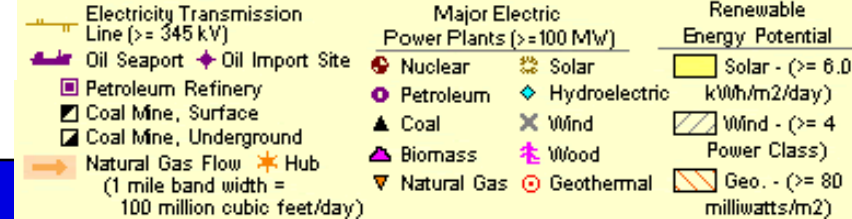
Data Sources: 2004, CEC Electricity Report which includes all renewables in the State, not just IOUs; 2010 and 2020, PIER Renewables Projections.

*RPS: Renewable Portfolio Standard; EAP Accelerated goal of 33% by 2020

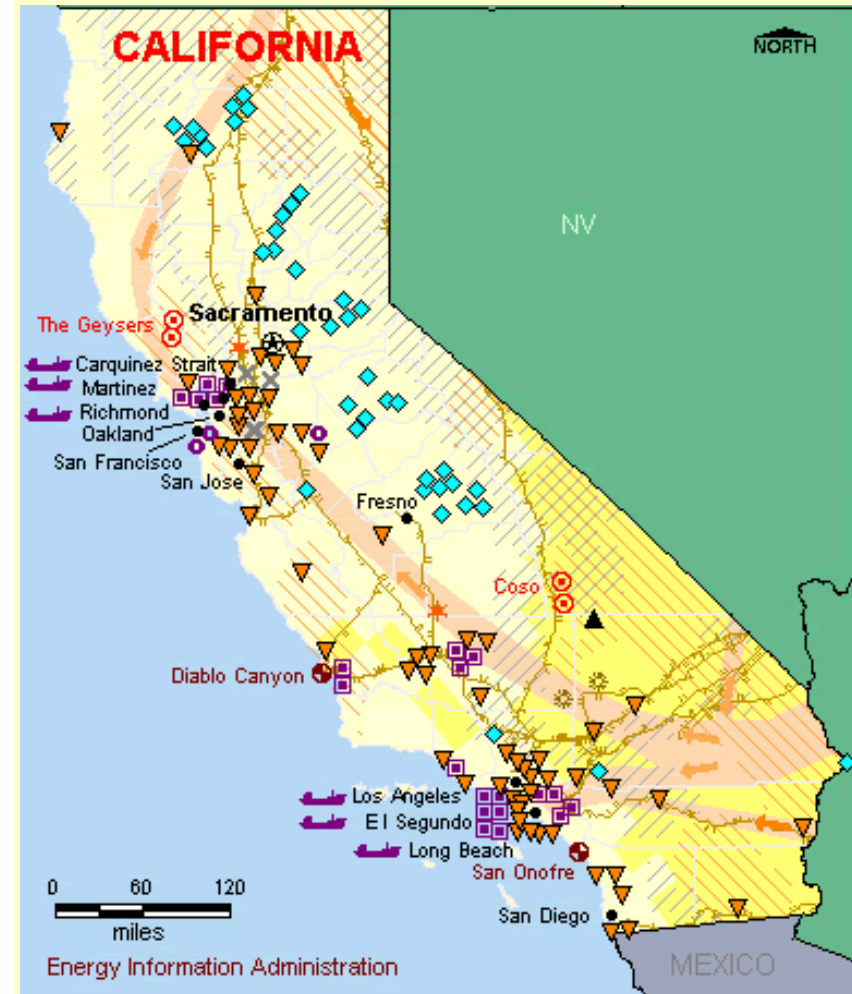
*CSI: California Solar Initiative

Integration Challenges

- Constrained and insufficient transmission and distribution (T&D) infrastructure
- Limited peak generating capacity and flexible units
- Lack of operating experience at high renewable penetration levels
- Abundant in-state renewable resources and aggressive policy for growth, but lacking a “game plan” (RPS) to help prioritize development
- Lack of integrated system
- Coordinated planning of resources outside of CA
- Aging infrastructure!!!



*Source: EIA



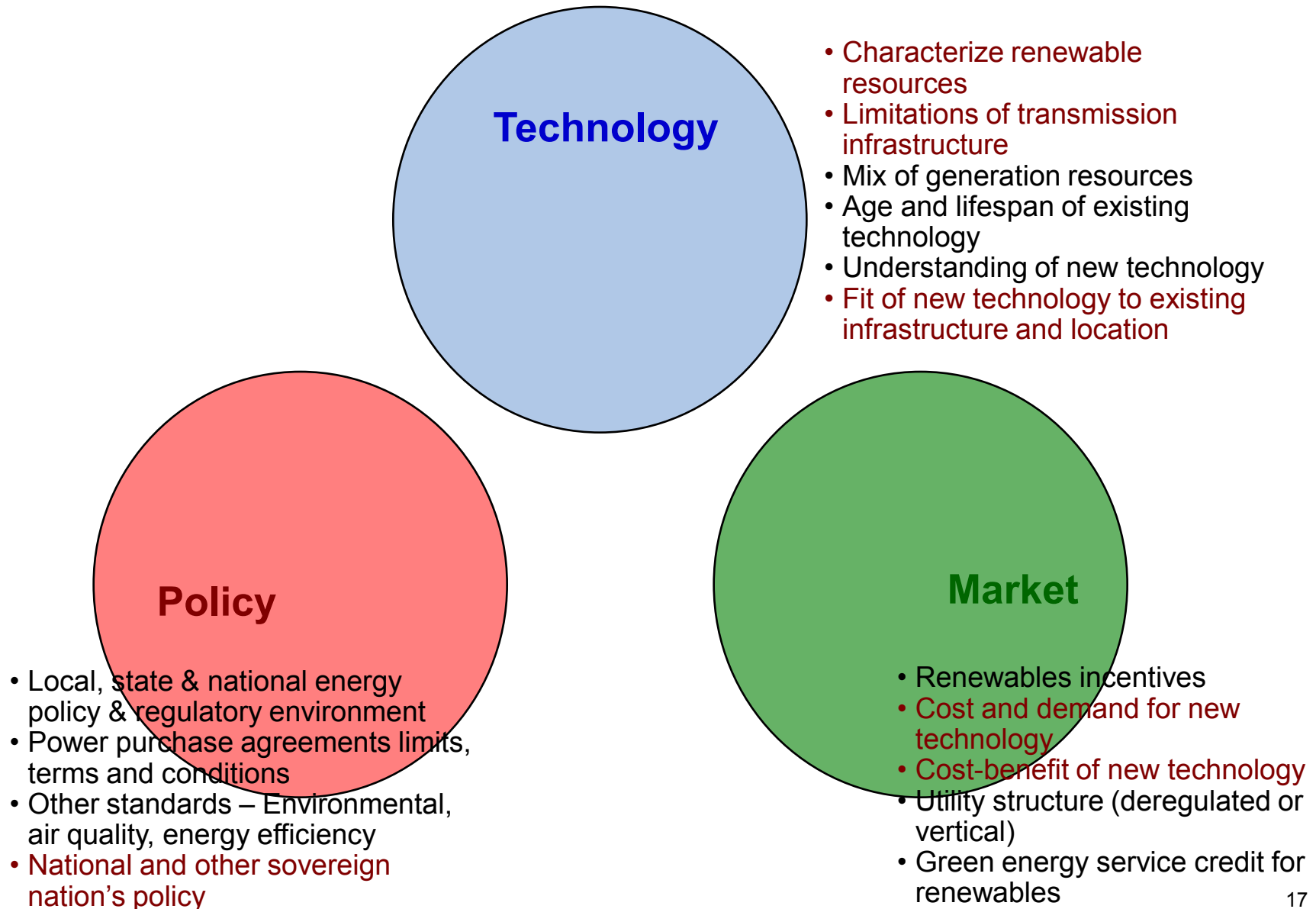


Renewable Integration Questions

- What will the future electricity system look like and where will renewable resources likely to come from – remote locations, distributed locations, out-of-state?
- What is needed for the grid to accommodate renewables (technologies/infrastructure, market, regulation)?
- What are the impacts of increasing renewable energy penetration on system reliability and dispatchability?
- Will the “planned” system last another 30-40 years?

How do you pull it all together?

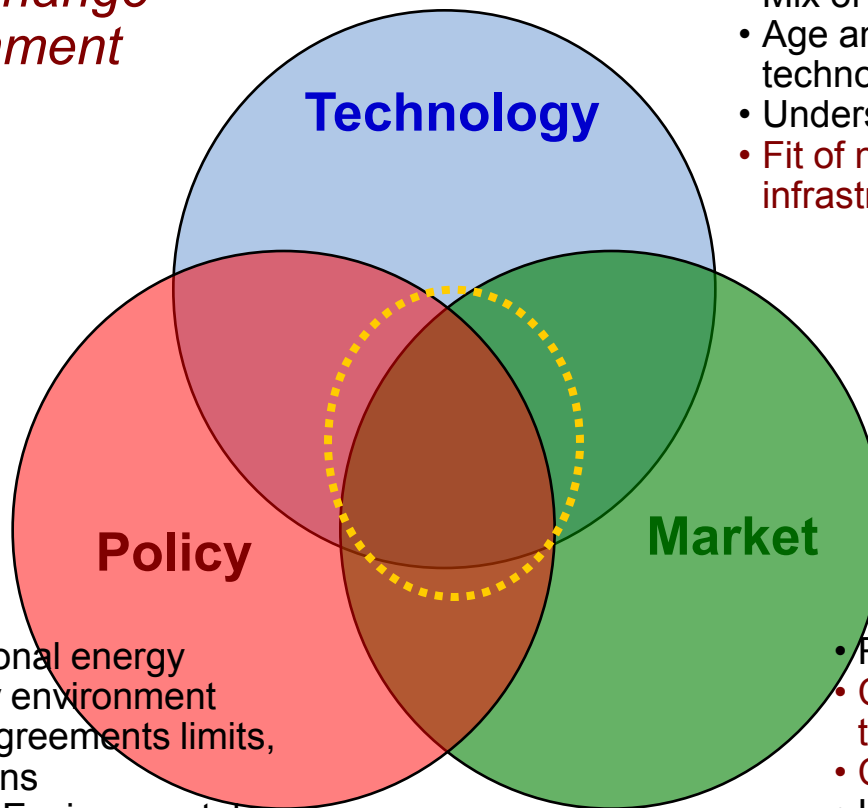
Three Pulls – Technology, Market, Policy/Regulatory



Three Pulls – Technology, Market, Policy/Regulatory



*Convergence of the 3 Pulls
often signifies a “change”
conducive environment*

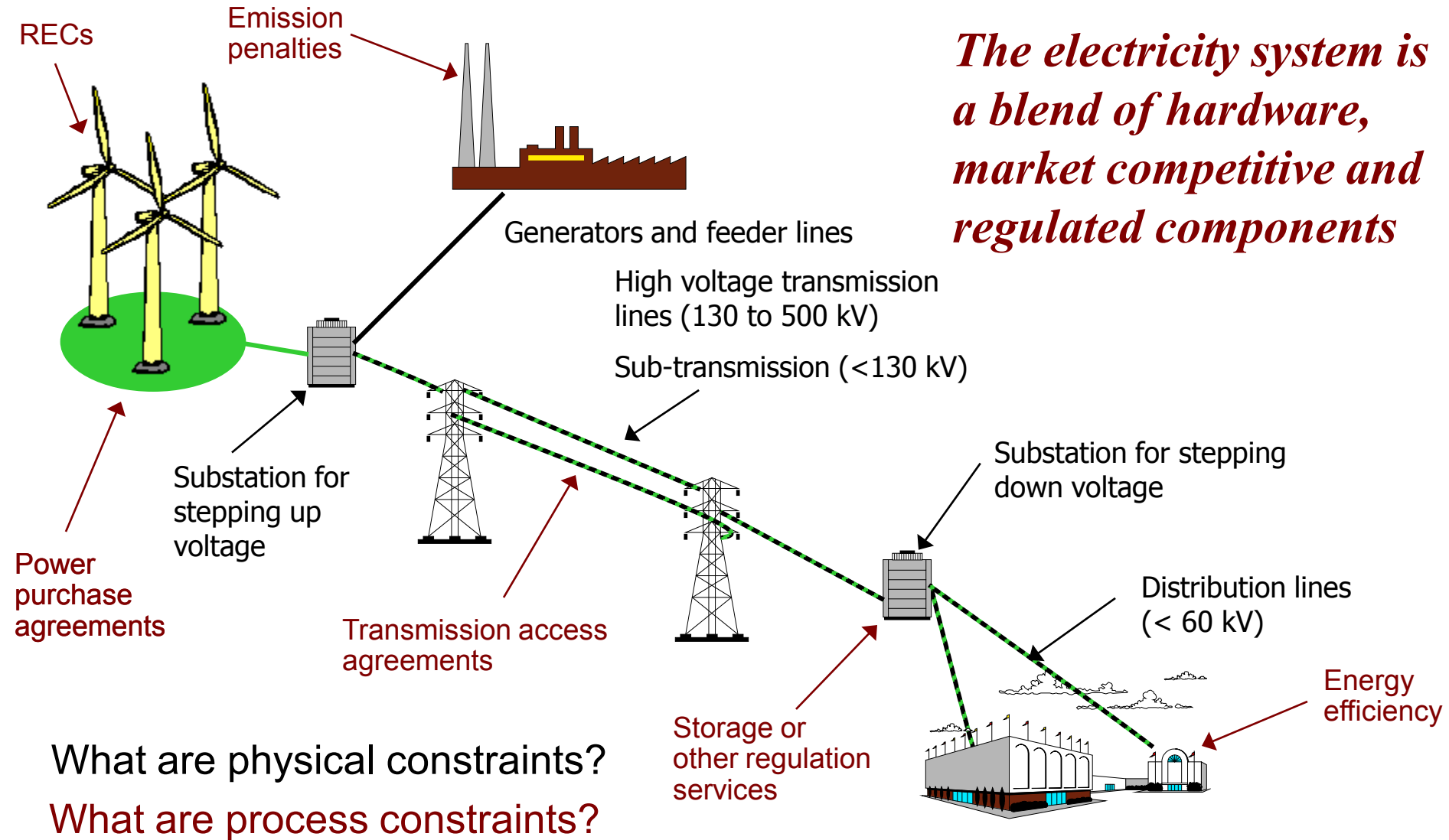


- Characterize renewable resources
- Limitations of transmission infrastructure
- Mix of generation resources
- Age and lifespan of existing technology
- Understanding of new technology
- Fit of new technology to existing infrastructure and location

- Local, state & national energy policy & regulatory environment
- Power purchase agreements limits, terms and conditions
- Other standards – Environmental, air quality, energy efficiency
- National and other sovereign nation's policy

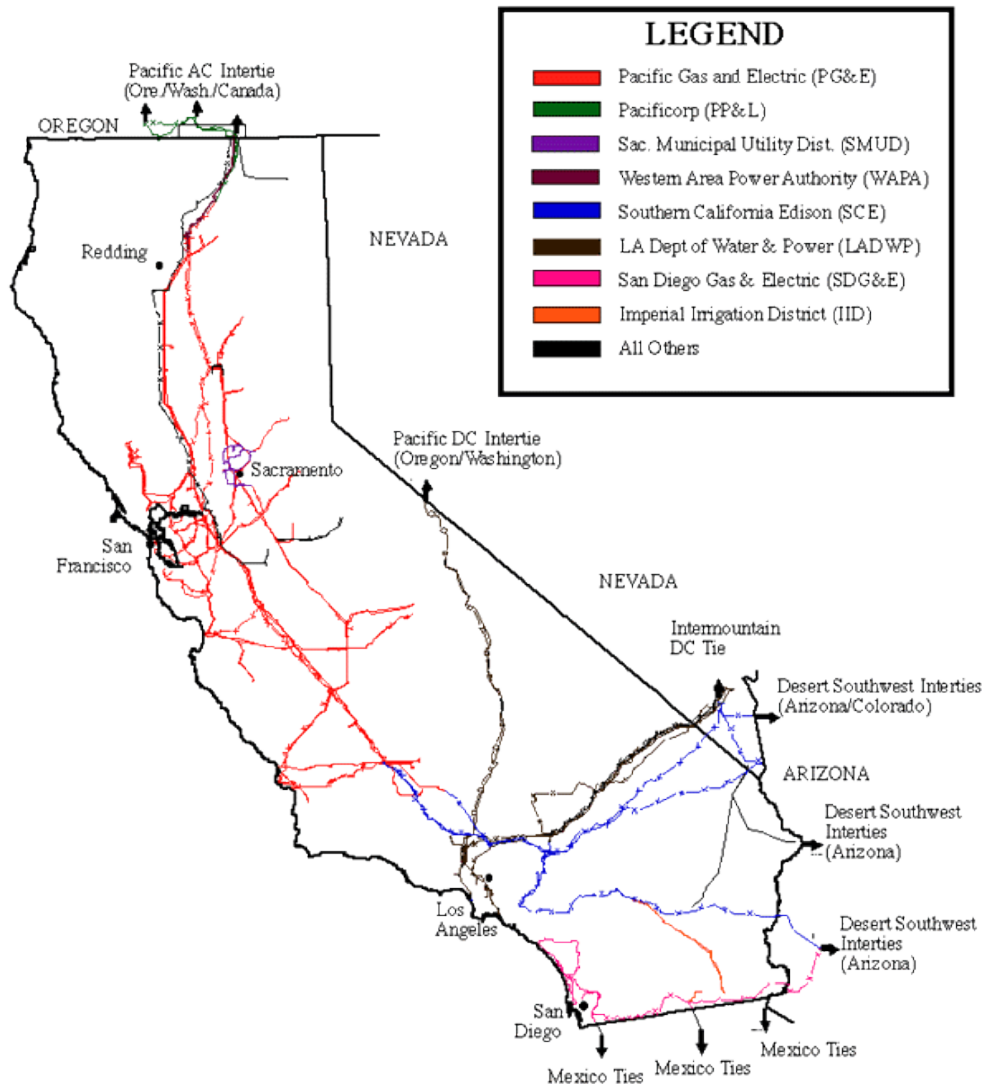
- Renewables incentives
- Cost and demand for new technology
- Cost-benefit of new technology
- Utility structure (deregulated or vertical)
- Green energy service credit for renewables

Components of the Grid





Technology – Lay of the Land



- Comprised of multiple utility service areas
- Mix of generation resources (base, peak, intermediate & intermittent)
- More than 124,000 miles of (T&D) power lines with over 2000 substations
- Supplies over 294 billion kilowatt-hours per year to 35 million Californians
- Electricity generation of over 61,000 MW supply electricity into California's grid
- 25% imported from out of state across high voltage DC lines

Planning and Daily Operational Needs

- Long-term Transmission Planning needs & Daily Operation needs are different
- Timescales for generation controls and performance vary across a wide range
- Added complexity due to market factors, technological maturity and infrastructure change

Slower (Years)
Time Frame
Faster (seconds)

Planning and Operation Process

Resource and Capacity Planning
(Reliability)

Unit Commitment and Day-Ahead Scheduling

Load Following
(5 Minute Dispatch)

Frequency and Tie-Line Regulation
(AGC)

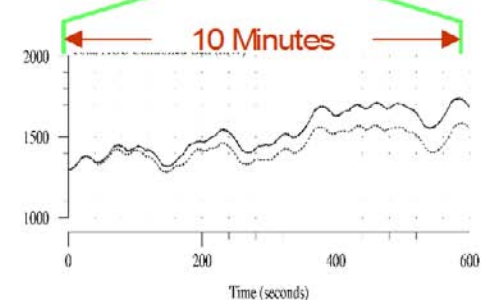
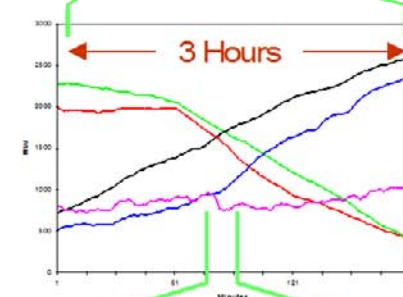
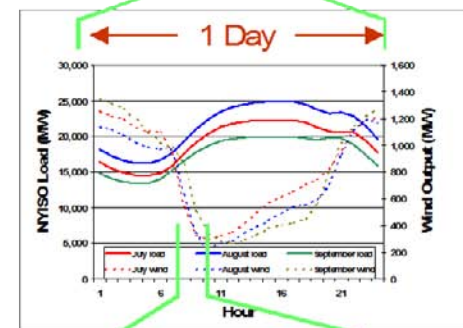
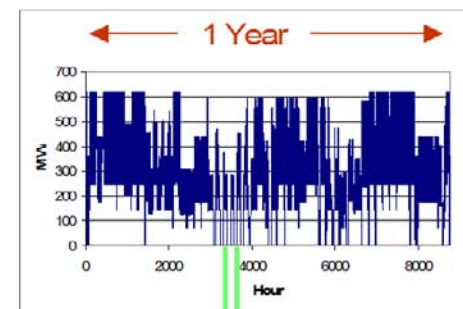
Technology Issues

Capacity Valuation (UCAP, ICAP) and Long-Term Load Growth Forecasting

Day-ahead and Multi-Day Forecasting

Hour-Ahead Forecasting and Plant Active Power Maneuvering and Management

Real-Time and Autonomous Protection and Control Functions (AGC, LVRT, PSS, Governor, V-Reg, etc.)



Begin to Pull Things Together

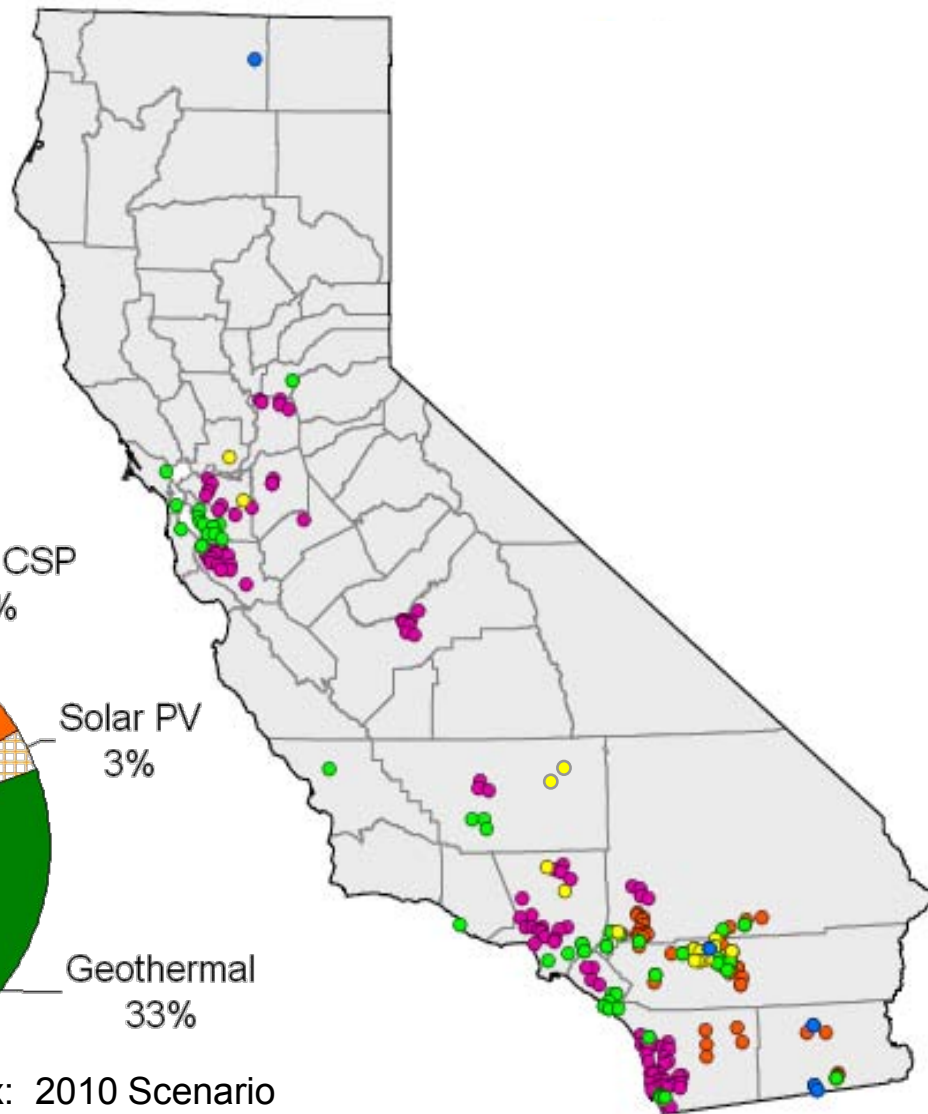
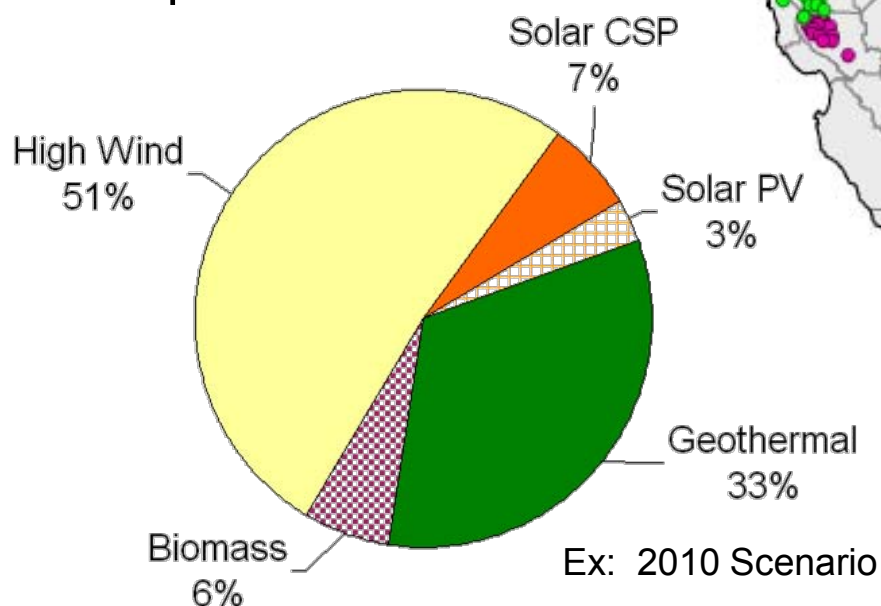


Examples of PIER and Renewable Energy Program efforts.

Developing Renewable Options



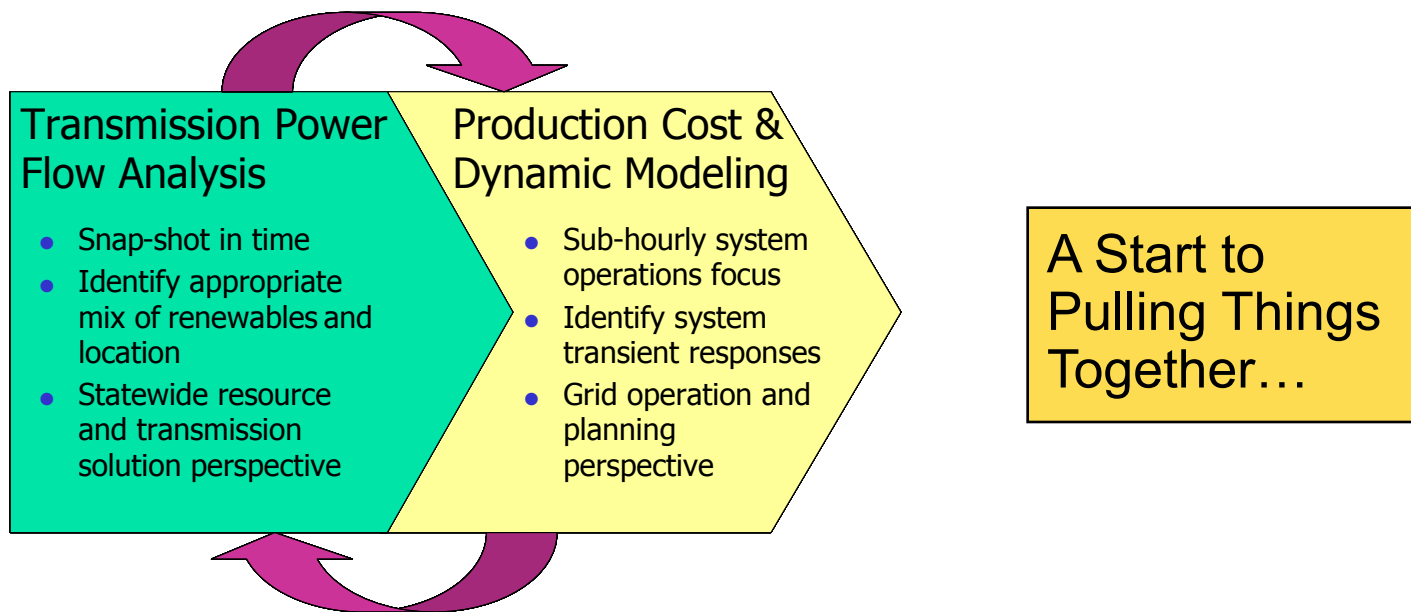
- Where are the resources?
- What are the electrical generation characteristics of the resource?
- How will it mix with existing resources
- How will it be connected?
- How can it be optimized?



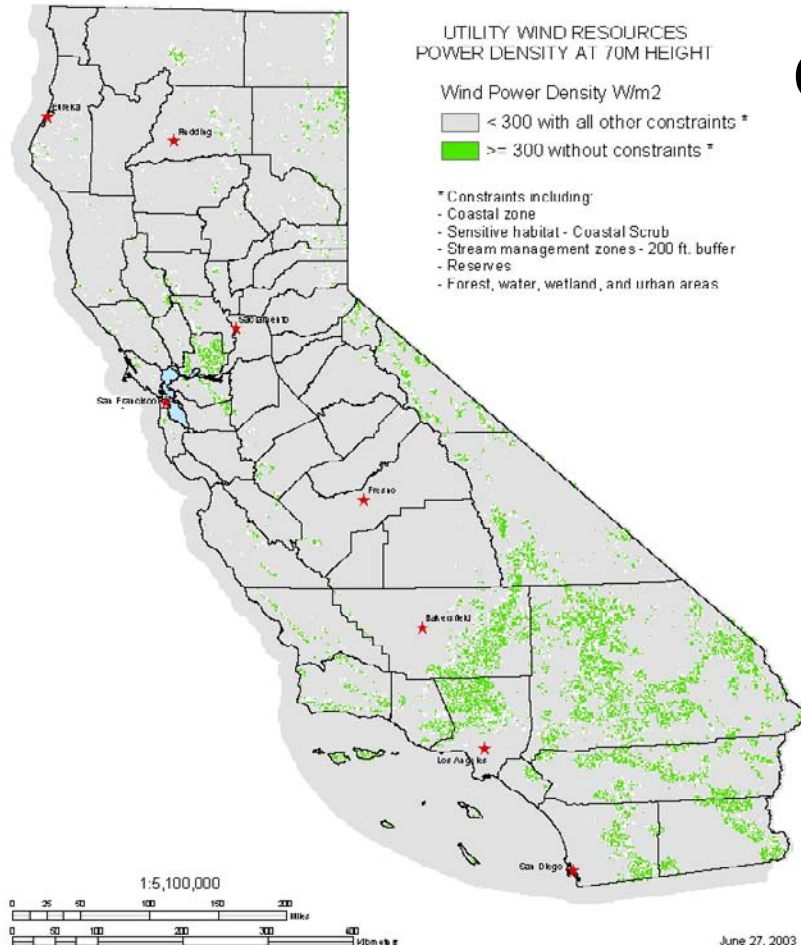
Scenario-based simulations to develop options



- Scenario-based analysis to help begin to pull things together from a state-wide perspective and explore options (Intermittency Analysis Project – IAP)
- Devising new tools and strategies to help communicate results



Refine Resource Assessments: Wind



Gross Wind Potential: 295,187 MW

Technical Potential*: 99,945 MW

Current Installed: 2,130 MW

Opportunity: 97,815 MW

Technical Filters (excluded areas):*

Resource > 300 W/m²

Topography grade > 20%

Bodies of Water

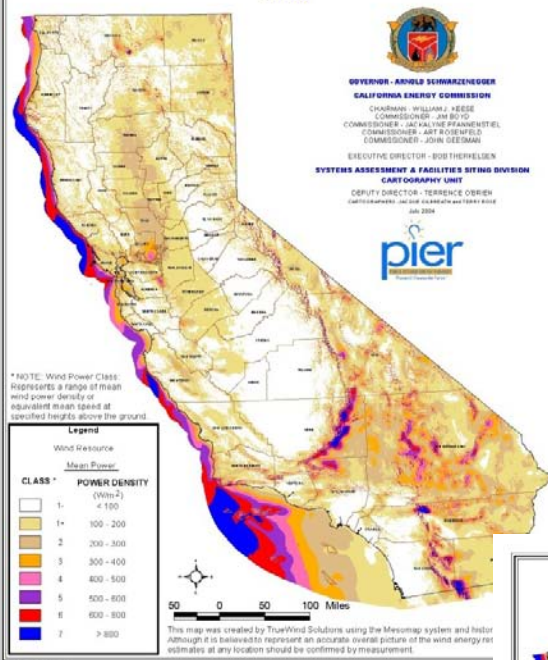
Forested Areas

Urban Areas

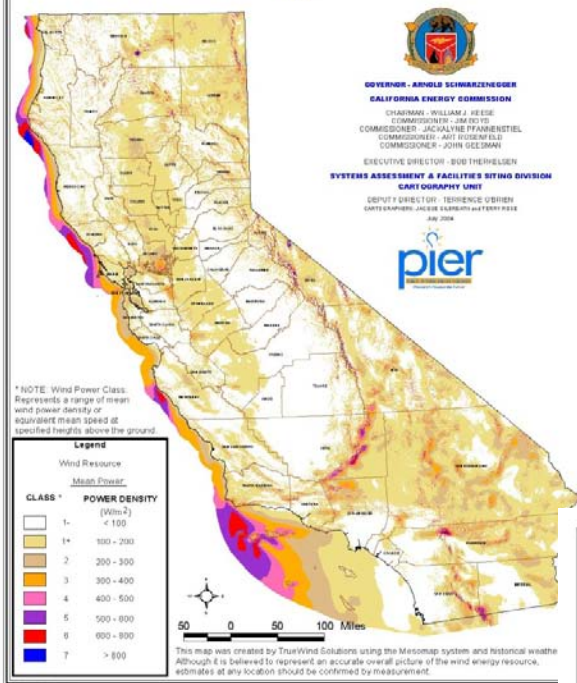
State/National Parks & Monuments

Others (Natural Reserves)

California Wind Resources Seasonal Wind Power at 50 Meter Elevation Spring



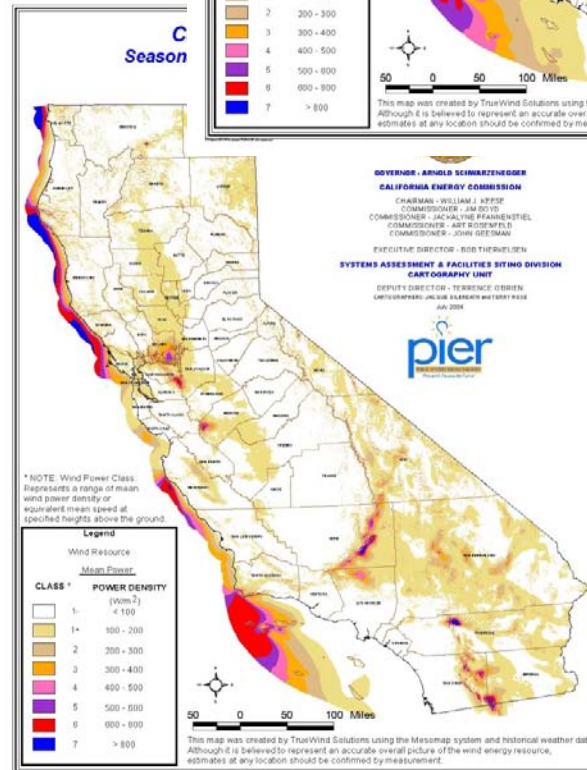
California Wind Resources Seasonal Wind Power at 50 Meter Elevation Fall



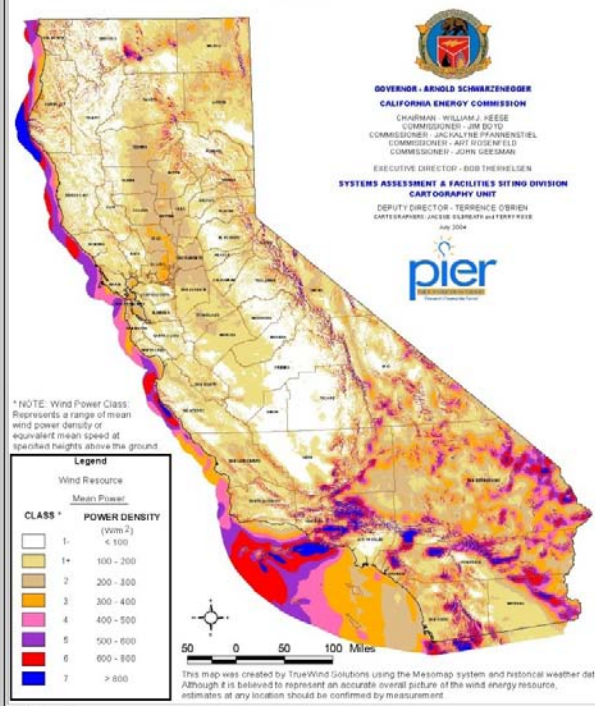
Understand Nature of Resources

Example of Wind Resource Forecasting Dependencies

1. Meteorology – Seasons
2. Geographic location
3. Topology
4. Data resolution



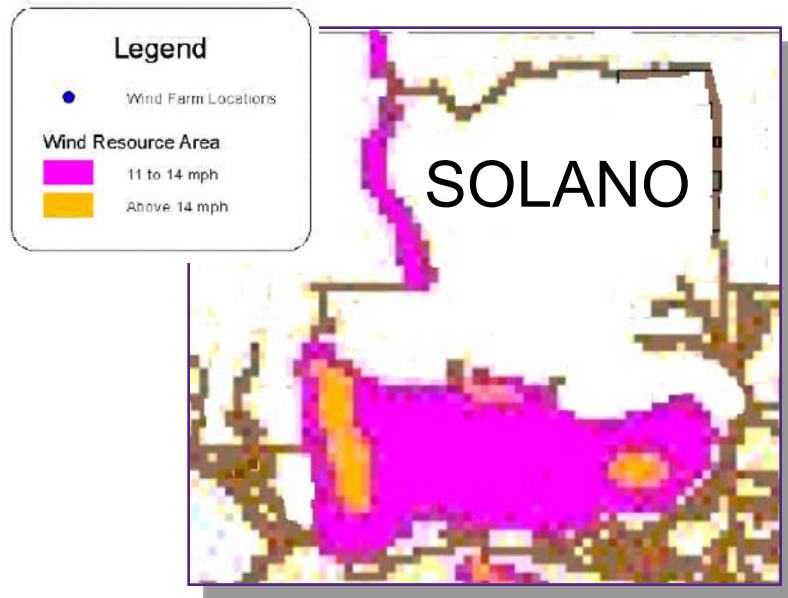
California Wind Resources Seasonal Wind Power at 50 Meter Elevation Winter



Tools to Increase Data Quality & Confidence

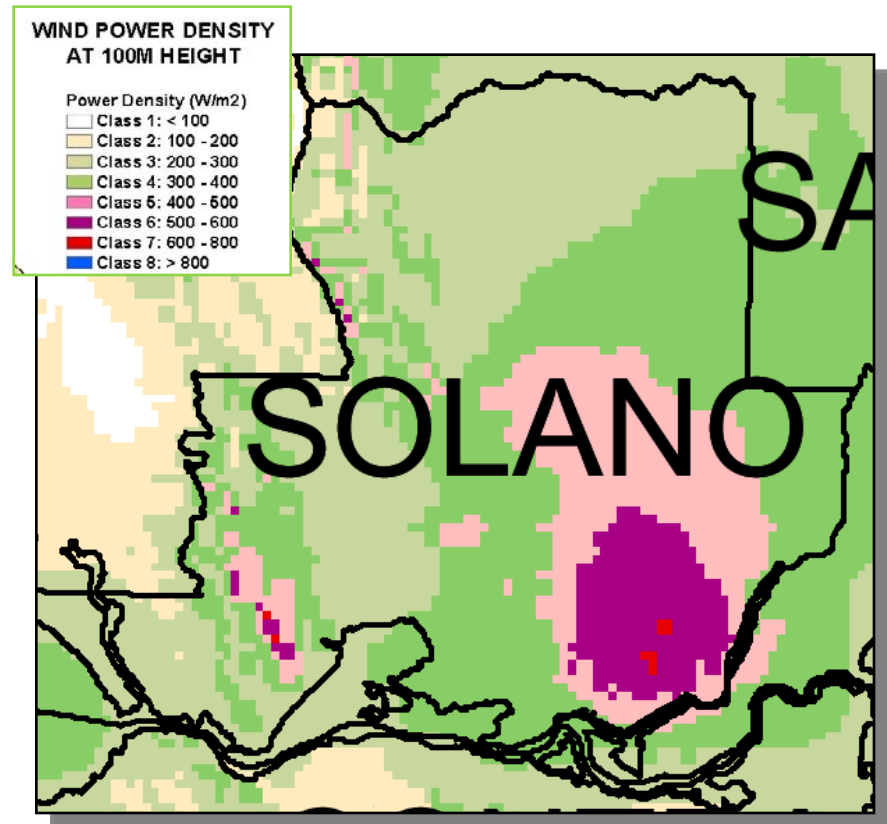


Improvements provided by high-resolution maps



Old Map

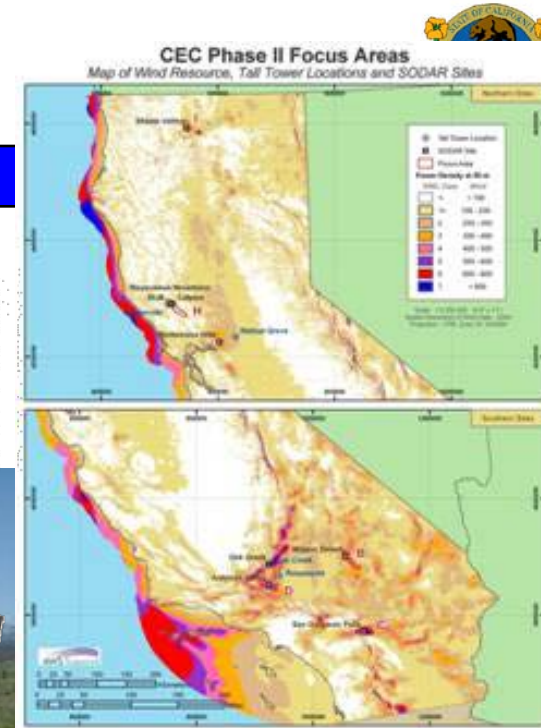
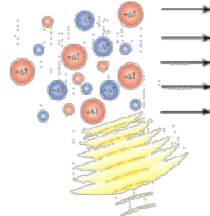
- Refines wind resource locations and new development potential
- Identifies additional land area for wind development



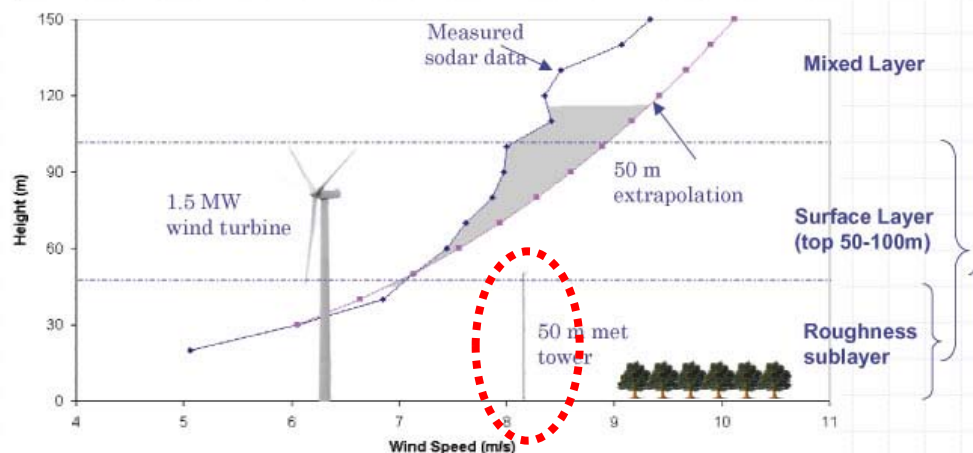
New Map and Data

Reduce Technology Risks

- Responds to industry's need to acquire accurate, upper atmospheric wind data within the operating regime of current wind turbine technologies
- Enables wind data to be remotely measured at elevations of 50m to 200m – typical heights of new turbine technologies
- Reduces development risk at new sites with wind data substantiated by tall tower and SODAR measurements
- Improves wind plant power prediction for energy generation and wind energy forecasting
- Industry participation: Calpine, Oakcreek, Enxco
- **Need measurement locations**



SODAR unit in the field



Communicate & Disseminate Information



California Wind Resource Analysis Site

Funding provided by:
California Energy Commission
Lawrence Livermore National Laboratory

Privacy & Legal Notice

Site Footprints

- San Geronio
- Altamont
- Pacheco
- Tehachapi
- Solano

GIS Fly Throughs

- Statewide
- Tehachapi
- Altamont

Altamont GIS Analysis

Avian Study Results

Bathymetry Overview

- North Coast
- Mid Coast
- South Coast
- San Diego

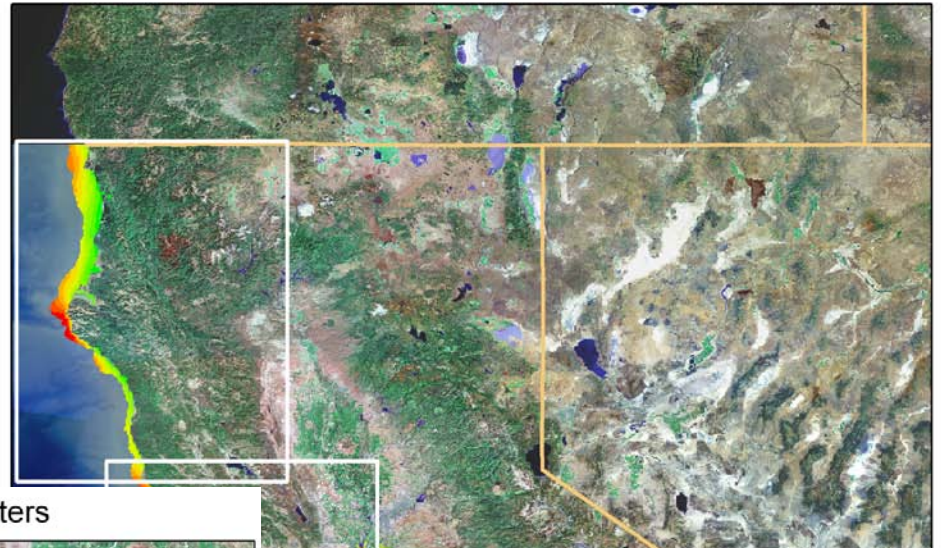
Reports

Contact Us











<http://eed.LLNL.gov/renewable>

Lawrence Livermore
National Laboratory

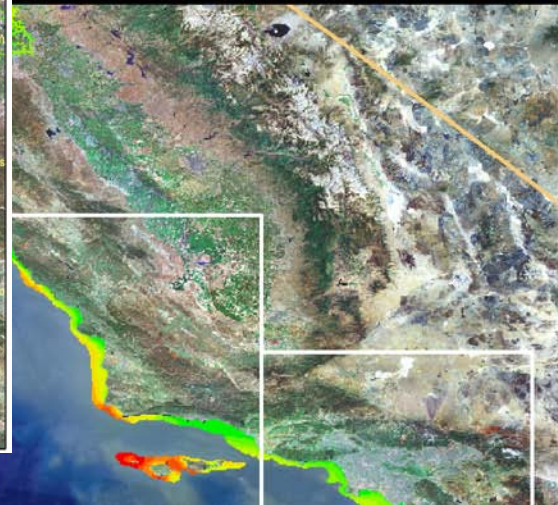
California Energy
Commission



the 1990s, the number of people in the United States who are 65 years of age or older has increased by 50 percent, and the number of people 75 years of age or older has increased by 100 percent. The number of people 85 years of age or older has increased by 200 percent. The number of people 95 years of age or older has increased by 400 percent. The number of people 100 years of age or older has increased by 1,000 percent. The number of people 105 years of age or older has increased by 2,000 percent. The number of people 110 years of age or older has increased by 4,000 percent. The number of people 115 years of age or older has increased by 8,000 percent. The number of people 120 years of age or older has increased by 16,000 percent. The number of people 125 years of age or older has increased by 32,000 percent. The number of people 130 years of age or older has increased by 64,000 percent. The number of people 135 years of age or older has increased by 128,000 percent. The number of people 140 years of age or older has increased by 256,000 percent. The number of people 145 years of age or older has increased by 512,000 percent. The number of people 150 years of age or older has increased by 1,024,000 percent. The number of people 155 years of age or older has increased by 2,048,000 percent. The number of people 160 years of age or older has increased by 4,096,000 percent. The number of people 165 years of age or older has increased by 8,192,000 percent. The number of people 170 years of age or older has increased by 16,384,000 percent. The number of people 175 years of age or older has increased by 32,768,000 percent. The number of people 180 years of age or older has increased by 65,536,000 percent. The number of people 185 years of age or older has increased by 131,072,000 percent. The number of people 190 years of age or older has increased by 262,144,000 percent. The number of people 195 years of age or older has increased by 524,288,000 percent. The number of people 200 years of age or older has increased by 1,048,576,000 percent. The number of people 205 years of age or older has increased by 2,097,152,000 percent. The number of people 210 years of age or older has increased by 4,194,304,000 percent. The number of people 215 years of age or older has increased by 8,388,608,000 percent. The number of people 220 years of age or older has increased by 16,777,216,000 percent. The number of people 225 years of age or older has increased by 33,554,432,000 percent. The number of people 230 years of age or older has increased by 67,108,864,000 percent. The number of people 235 years of age or older has increased by 134,217,728,000 percent. The number of people 240 years of age or older has increased by 268,435,456,000 percent. The number of people 245 years of age or older has increased by 536,870,912,000 percent. The number of people 250 years of age or older has increased by 1,073,741,824,000 percent. The number of people 255 years of age or older has increased by 2,147,483,648,000 percent. The number of people 260 years of age or older has increased by 4,294,967,296,000 percent. The number of people 265 years of age or older has increased by 8,589,934,592,000 percent. The number of people 270 years of age or older has increased by 17,179,869,184,000 percent. The number of people 275 years of age or older has increased by 34,359,738,368,000 percent. The number of people 280 years of age or older has increased by 68,719,476,736,000 percent. The number of people 285 years of age or older has increased by 137,438,953,472,000 percent. The number of people 290 years of age or older has increased by 274,877,906,944,000 percent. The number of people 295 years of age or older has increased by 549,755,813,888,000 percent. The number of people 300 years of age or older has increased by 1,099,511,627,776,000 percent. The number of people 305 years of age or older has increased by 2,199,023,255,552,000 percent. The number of people 310 years of age or older has increased by 4,398,046,511,104,000 percent. The number of people 315 years of age or older has increased by 8,796,093,022,208,000 percent. The number of people 320 years of age or older has increased by 17,592,186,044,416,000 percent. The number of people 325 years of age or older has increased by 35,184,372,088,832,000 percent. The number of people 330 years of age or older has increased by 70,368,744,177,664,000 percent. The number of people 335 years of age or older has increased by 140,737,488,355,328,000 percent. The number of people 340 years of age or older has increased by 281,474,976,710,656,000 percent. The number of people 345 years of age or older has increased by 562,949,953,421,312,000 percent. The number of people 350 years of age or older has increased by 1,125,899,906,842,624,000 percent. The number of people 355 years of age or older has increased by 2,251,799,813,685,248,000 percent. The number of people 360 years of age or older has increased by 4,503,599,627,370,496,000 percent. The number of people 365 years of age or older has increased by 9,007,199,254,740,992,000 percent. The number of people 370 years of age or older has increased by 18,014,398,509,481,984,000 percent. The number of people 375 years of age or older has increased by 36,028,797,018,963,968,000 percent. The number of people 380 years of age or older has increased by 72,057,594,037,927,936,000 percent. The number of people 385 years of age or older has increased by 144,115,188,075,855,872,000 percent. The number of people 390 years of age or older has increased by 288,230,376,151,711,744,000 percent. The number of people 395 years of age or older has increased by 576,460,752,303,423,488,000 percent. The number of people 400 years of age or older has increased by 1,152,921,504,606,846,976,000 percent. The number of people 405 years of age or older has increased by 2,305,843,009,213,693,952,000 percent. The number of people 410 years of age or older has increased by 4,611,686,018,427,387,904,000 percent. The number of people 415 years of age or older has increased by 9,223,372,036,854,775,808,000 percent. The number of people 420 years of age or older has increased by 18,446,744,073,709,551,616,000 percent. The number of people 425 years of age or older has increased by 36,893,488,147,419,103,232,000 percent. The number of people 430 years of age or older has increased by 73,786,976,294,838,206,464,000 percent. The number of people 435 years of age or older has increased by 147,573,952,589,676,412,928,000 percent. The number of people 440 years of age or older has increased by 295,147,905,179,352,825,856,000 percent. The number of people 445 years of age or older has increased by 590,295,810,358,705,651,712,000 percent. The number of people 450 years of age or older has increased by 1,180,591,620,717,411,303,424,000 percent. The number of people 455 years of age or older has increased by 2,361,183,241,434,822,606,848,000 percent. The number of people 460 years of age or older has increased by 4,722,366,482,869,645,213,696,000 percent. The number of people 465 years of age or older has increased by 9,444,732,965,739,290,427,392,000 percent. The number of people 470 years of age or older has increased by 18,889,465,931,478,580,854,784,000 percent. The number of people 475 years of age or older has increased by 37,778,931,862,957,161,709,568,000 percent. The number of people 480 years of age or older has increased by 75,557,863,725,914,323,419,136,000 percent. The number of people 485 years of age or older has increased by 151,115,727,451,828,646,838,272,000 percent. The number of people 490 years of age or older has increased by 302,231,454,903,657,293,676,544,000 percent. The number of people 495 years of age or older has increased by 604,462,909,807,314,587,353,088,000 percent. The number of people 500 years of age or older has increased by 1,208,925,819,614,629,174,706,176,000 percent. The number of people 505 years of age or older has increased by 2,417,851,639,229,258,349,412,352,000 percent. The number of people 510 years of age or older has increased by 4,835,703,278,458,516,698,824,704,000 percent. The number of people 515 years of age or older has increased by 9,671,406,556,917,033,397,649,408,000 percent. The number of people 520 years of age or older has increased by 19,342,813,113,834,066,795,298,816,000 percent. The number of people 525 years of age or older has increased by 38,685,626,227,668,133,590,597,632,000 percent. The number of people 530 years of age or older has increased by 77,371,252,455,336,267,181,195,264,000 percent. The number of people 535 years of age or older has increased by 154,742,504,910,672,534,362,390,528,000 percent. The number of people 540 years of age or older has increased by 309,485,009,821,345,068,724,781,056,000 percent. The number of people 545 years of age or older has increased by 618,970,019,642,690,137,449,562,112,000 percent. The number of people 550 years of age or older has increased by 1,237,940,039,285,380,274,899,124,224,000 percent. The number of people 555 years of age or older has increased by 2,475,880,078,570,760,549,798,248,448,000 percent. The number of people 560 years of age or older has increased by 4,951,760,157,141,521,099,596,496,896,000 percent. The number of people 565 years of age or older has increased by 9,903,520,314,283,042,199,193,993,792,000 percent. The number of people 570 years of age or older has increased by 19,807,040,628,566,084,398,387,

	Class 1: <4.5
	Class 2: $4.5 - 5.0$
	Class 3: $5.0 - 5.5$
	Class 4: $5.5 - 6.0$
	Class 5: $6.0 - 6.5$
	Class 6: $6.5 - 7.0$
	Class 7: $7.0 - 7.5$
	Class 8: $7.5 - 8.0$
	Class 9: $8.0 - 8.5$
	Class 10: > 8.5

Low : -4380

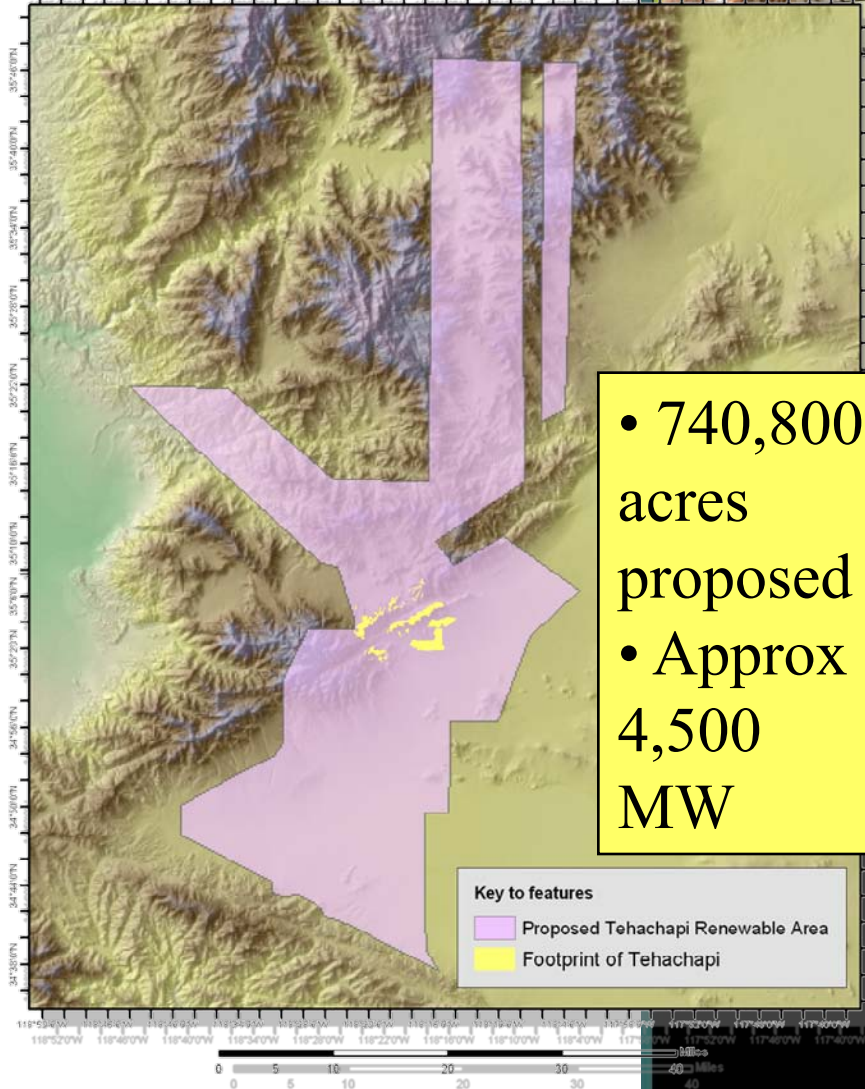


Expansion Impacts & Concerns

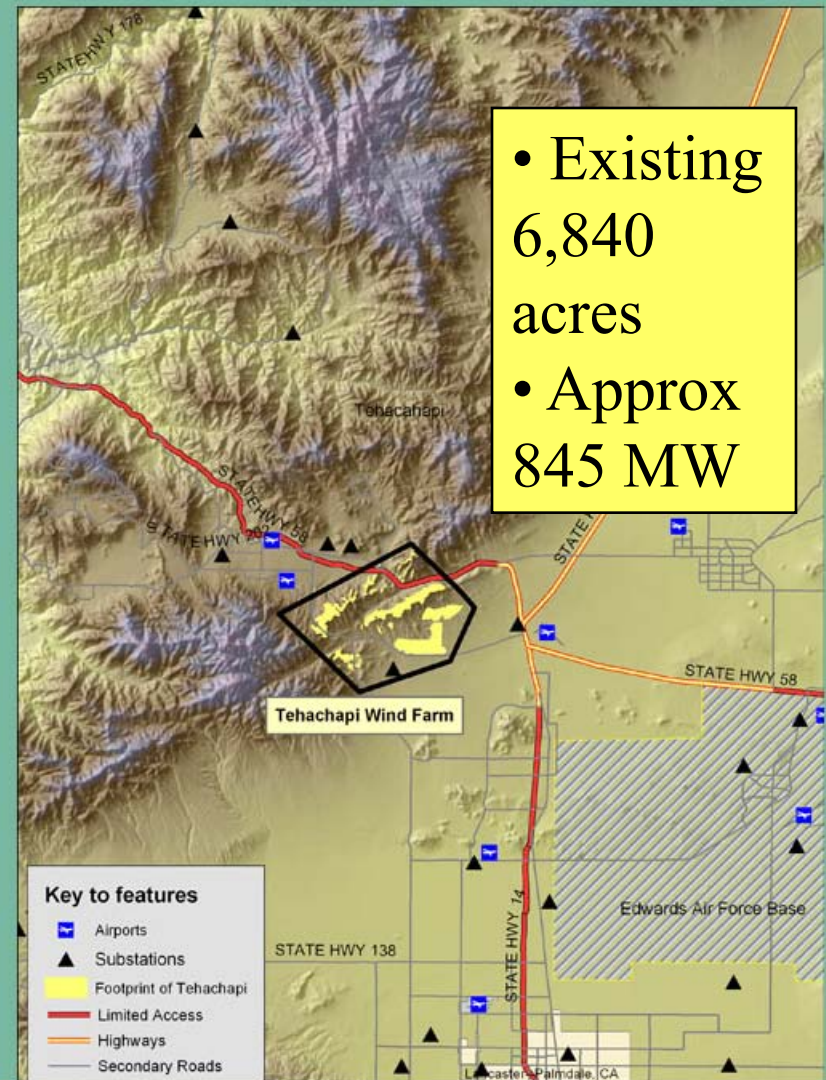


California Energy Commission *Wind Resource Analysis Site*

Tehachapi Wind Farm



- 740,800 acres proposed
- Approx 4,500 MW



- Existing 6,840 acres
- Approx 845 MW




Assess Cultural, Community and other Land Impacts

Do Visibility

1. Change observer height and radius (if needed).

Height of observer: 60 meters

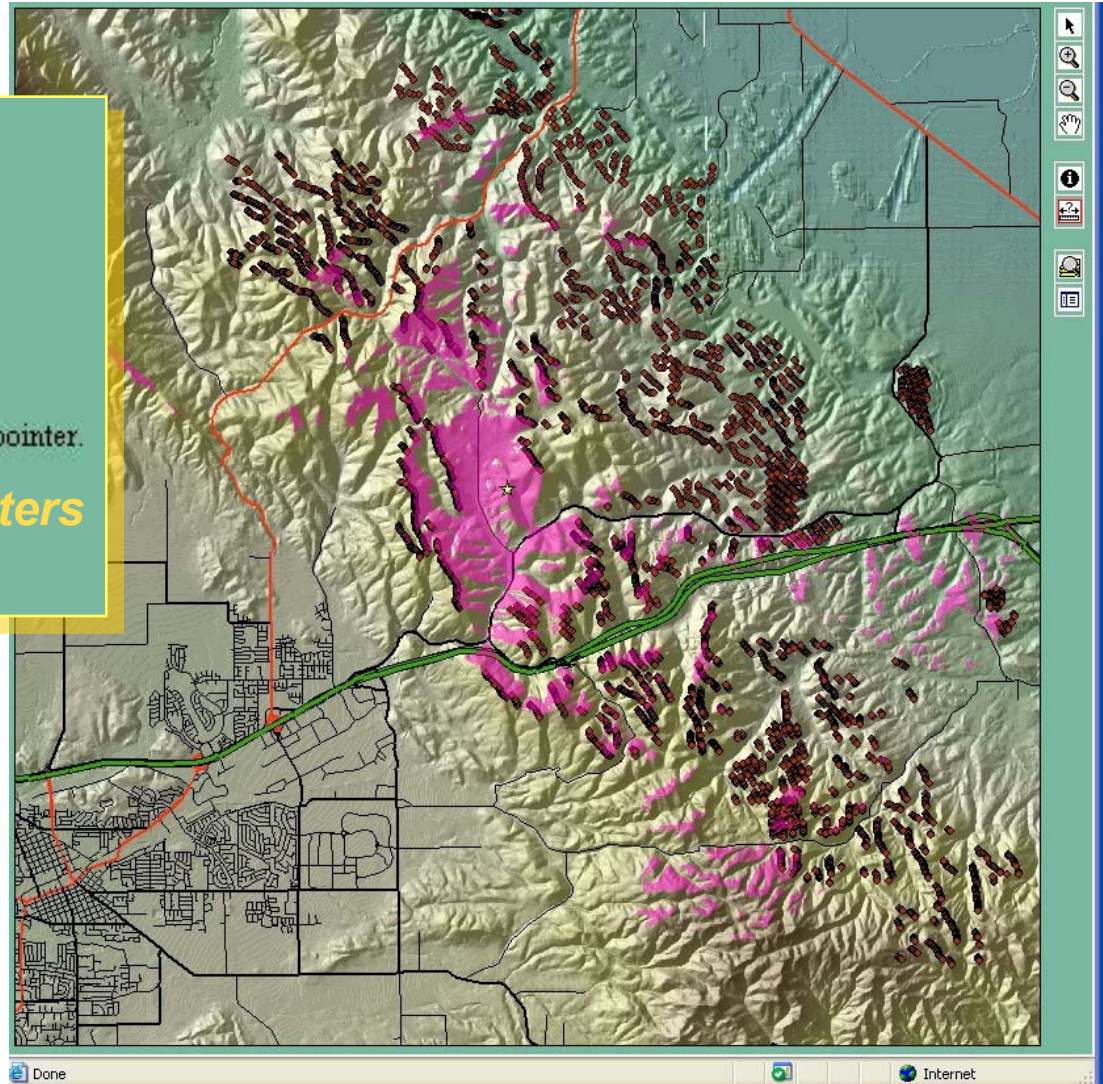
Radius from observer: 10000 meters

2. Place observer by clicking on the map with the  pointer.

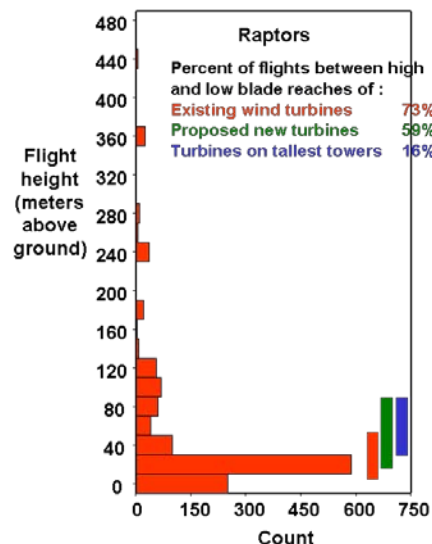
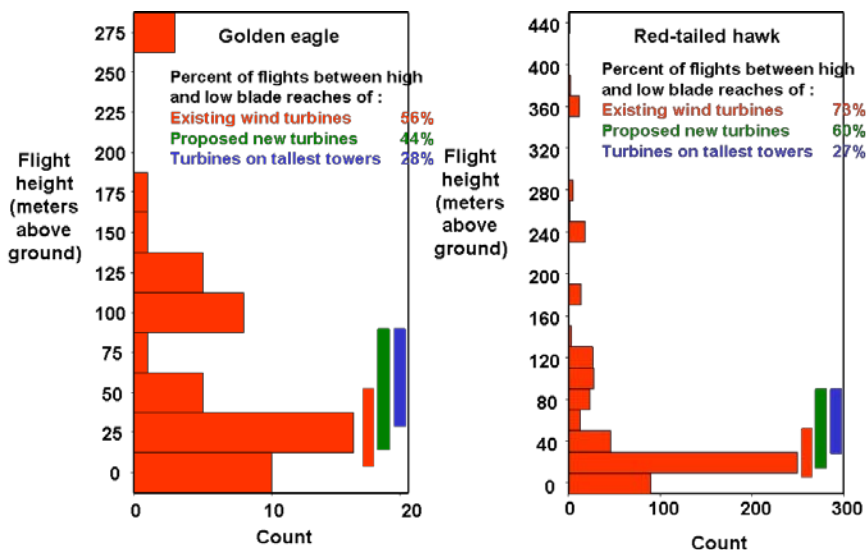
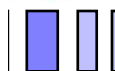
User defined analysis parameters

Done / Finished

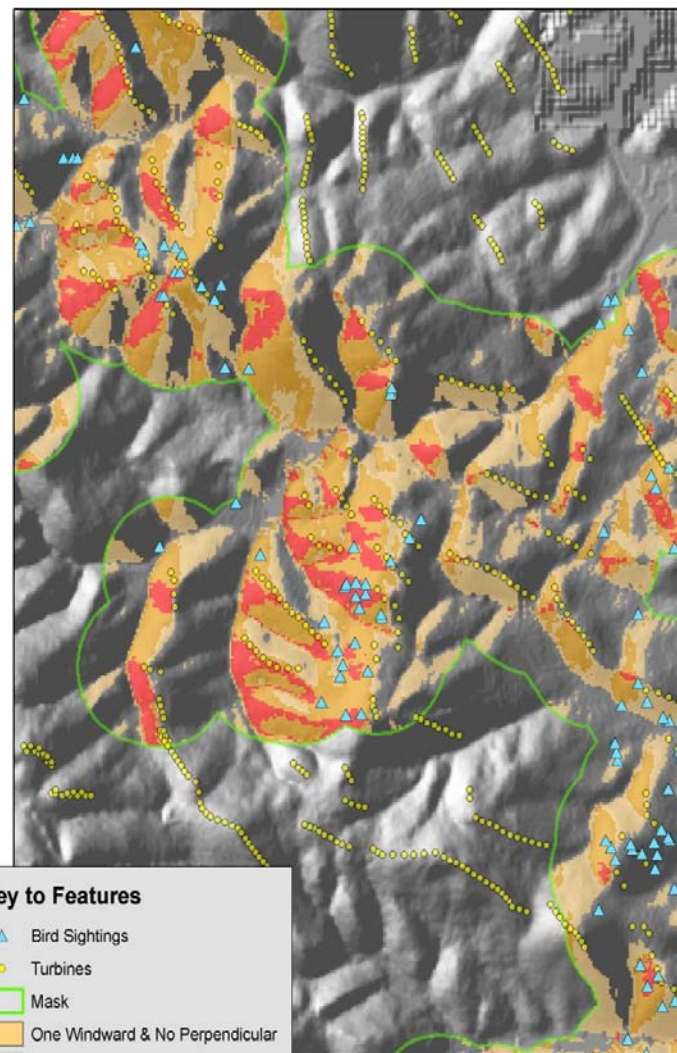
Allows users to perform impact analysis by choosing a turbine hub height, a coverage area and then calculate land that the light source is visible from



Understand Impact on Nature



Orientation of DEM to NW & SW Winds



Key to Features

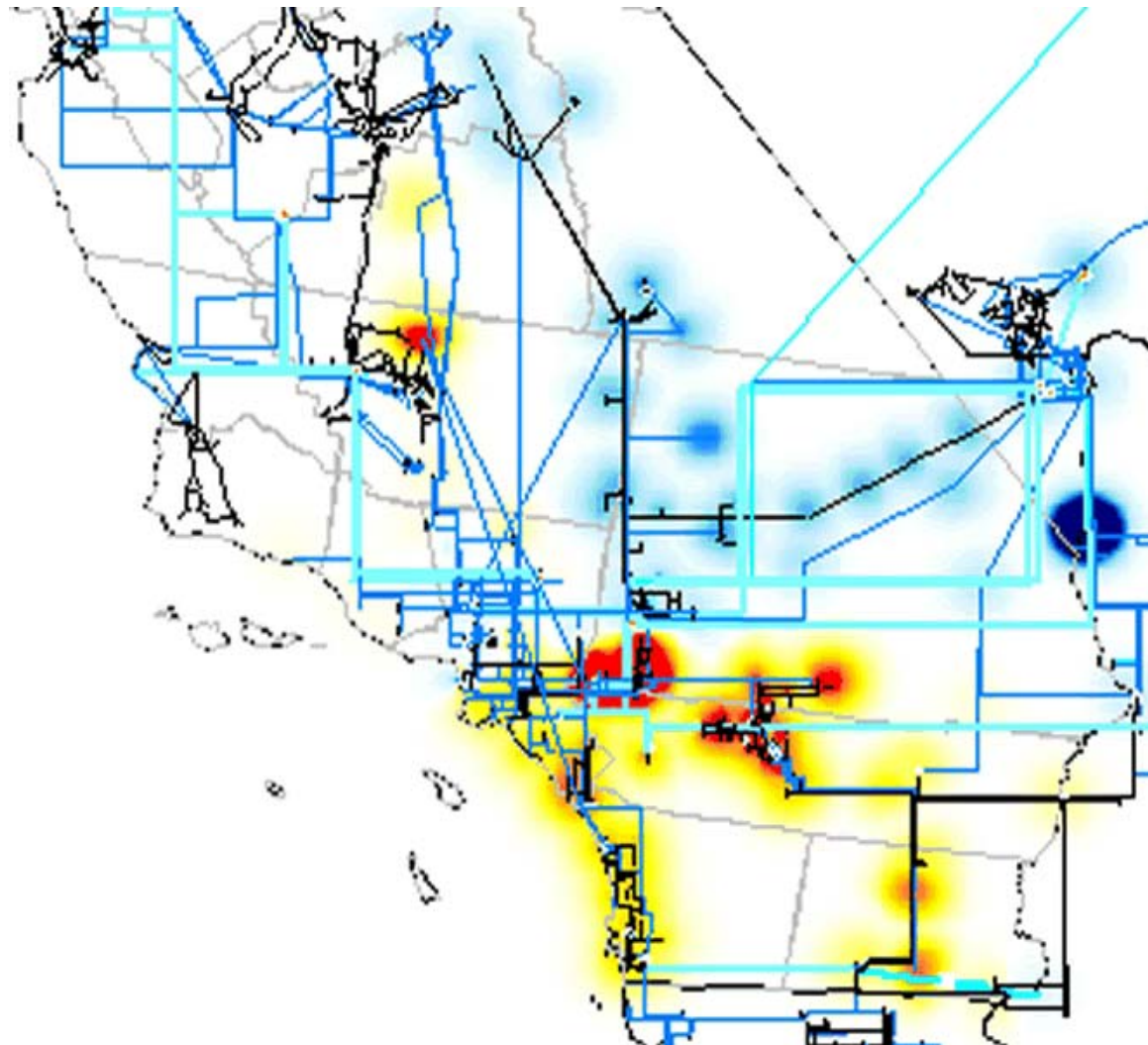
- ▲ Bird Sightings
- Turbines
- Mask
- One Windward & No Perpendicular
- Both Either Windward or Perp
- Both Windward

Miles
0.0 0.1 0.2 0.3 0.4

Series of statistical data converted into more comprehensible graphical data analysis layers. Results translate in locations where wind turbines may be re-sited to have less impact on the avian mortality

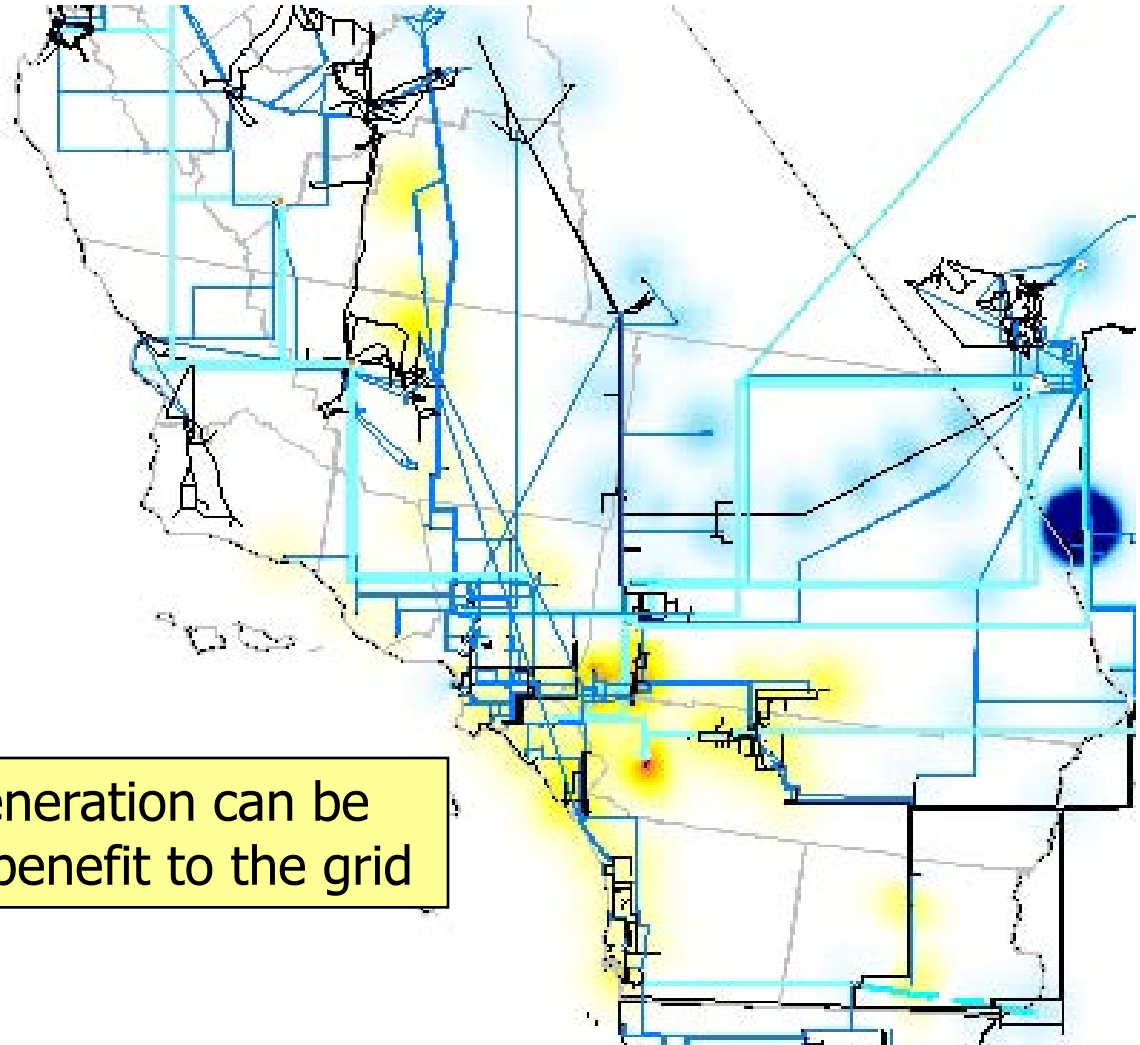
Reduce Transmission Congestion

- Compute Transmission Loading Relief Sensitivities to find **high impact buses**
- Transmission congestion areas or “**hot spots**” ranked by areas where new generation would be beneficial
 - Red area highest ranking
 - Yellow area next highest
 - Blue area least desirable



After Renewable Injection

- Strategically located resources reduces “hot spots” significantly
- Overall system benefit by injecting resources at location



Shape where renewable generation can be placed to provide overall benefit to the grid

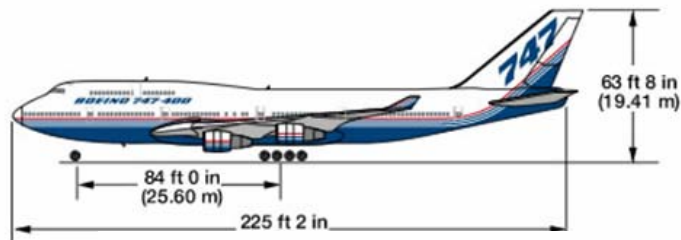
Plan for Renewable Resource Seasonality and Geographic Diversity



Region	Resource	Spring	Summer	Fall
Medicine Lake	Geothermal	X	Neutral	X
Imperial Valley	Geothermal	X	Neutral	
Sulfur Bank	Geothermal			Neutral
LADWP	Wind		X	X
Altamont Pass	Wind	X		
Solano	Wind	X		X
Tehachapi	Wind		Neutral	X
Central Valley	Biomass			X
SDG&E	CSP		Neutral	Neutral
SCE	CSP			Neutral
Residential	PV			Neutral

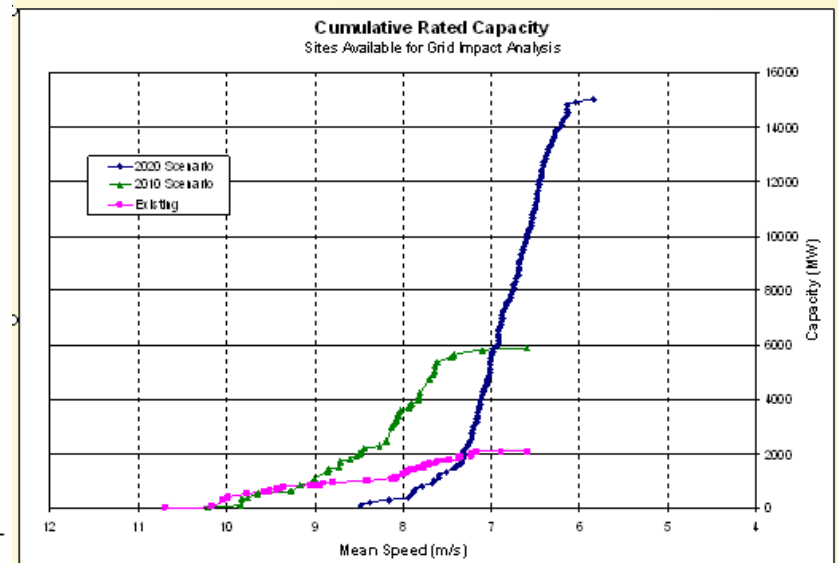
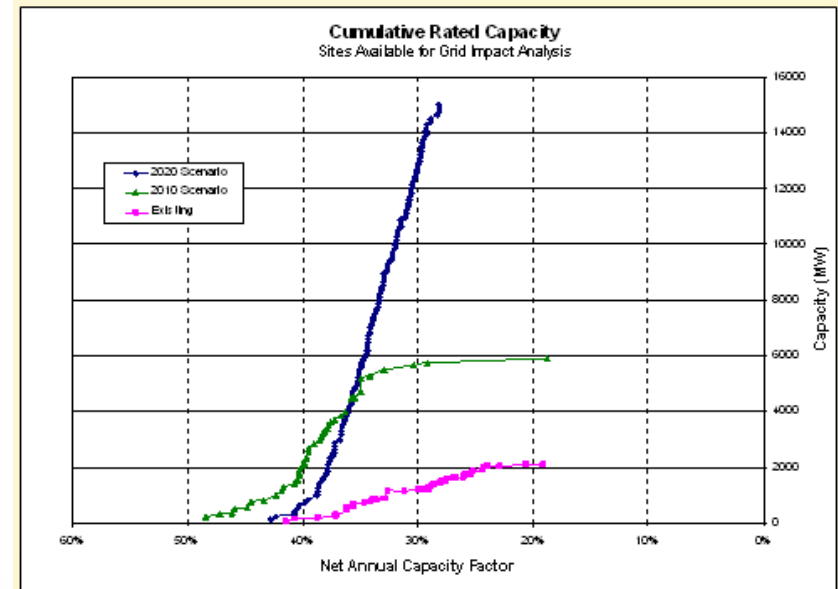
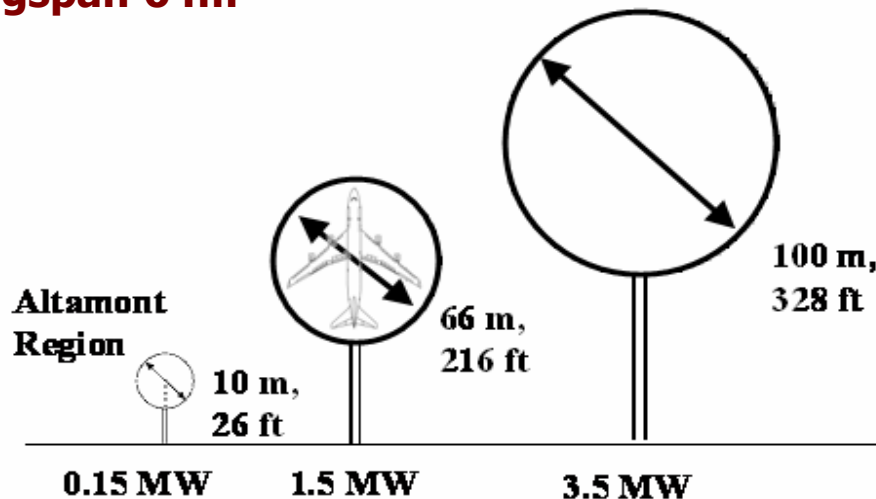
Factor Change in Technologies

- Phase out of older technologies
- New performance capabilities
- New grid-friendlier advance power electronics and controls



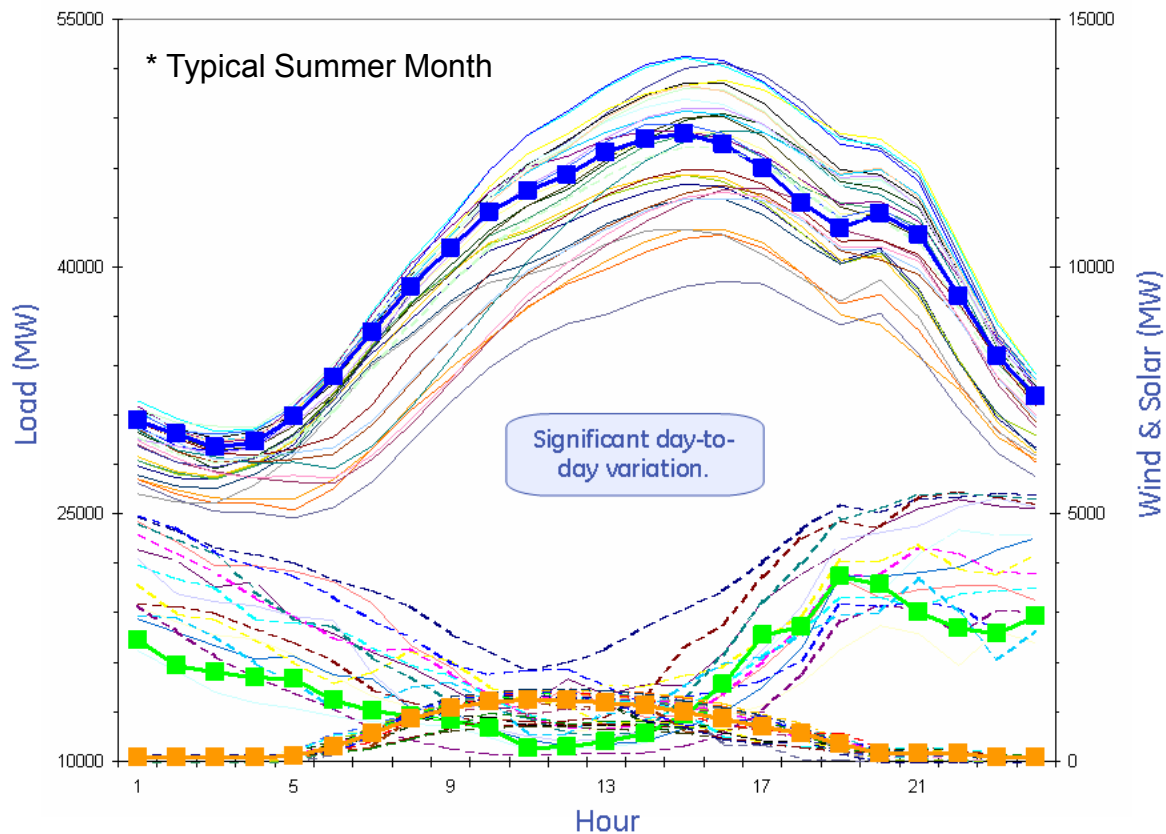
Boeing 747-400
Wingspan 64m

Modern turbines



Managing the Mix

- Striking a balance between changing demand and supply
- Do it at the least cost
- Do it without sacrificing reliability
- Do it so it can be sustained



Current Paradigm

$$Demand = Supply$$

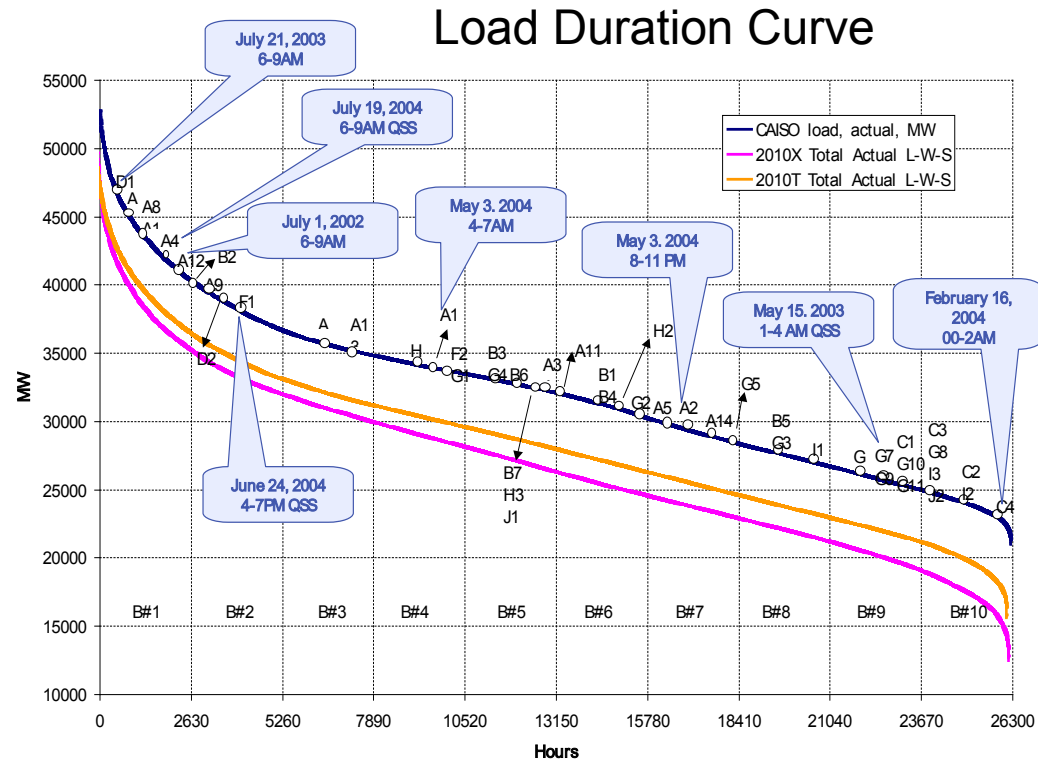
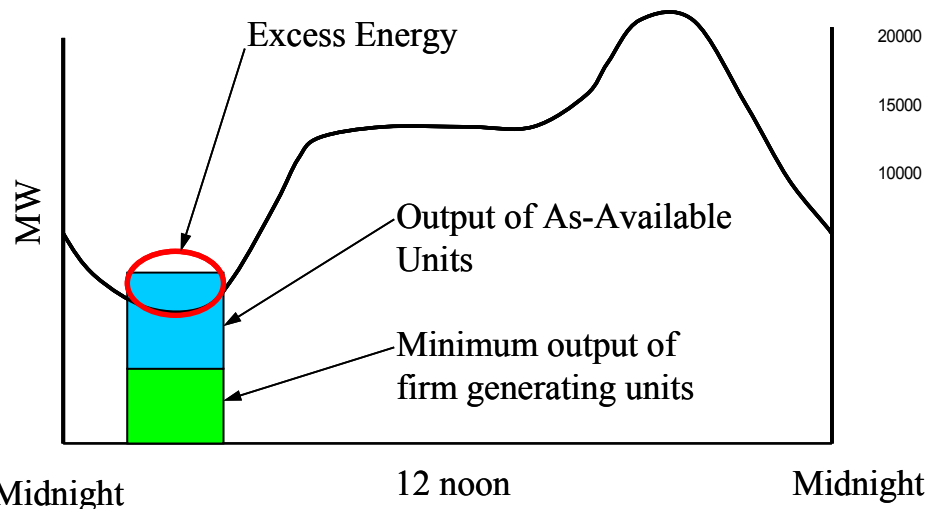
Emerging Paradigm

$$Demand = Supply + \sum_{0}^{\infty} VariableSupply$$



Understand the Time Periods of Interest & Value

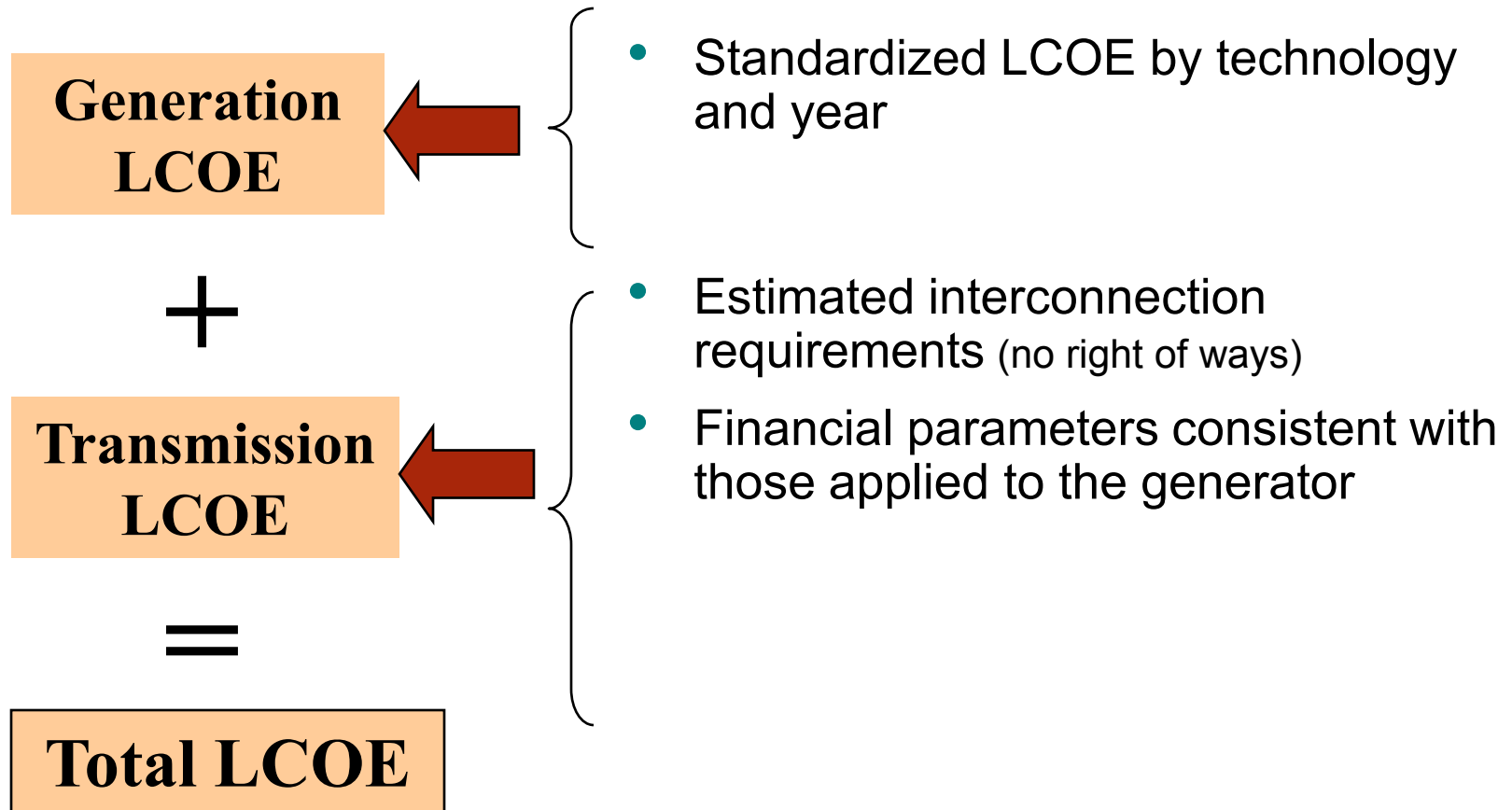
- Limiting Conditions & Duration
 - July morning, load rise
 - February night, light load
 - June evening, load decrease
- Hourly and sub-hourly periods of analysis



What to do with the excess energy?

- Today's solution
- Tomorrow's solution
- Permanent solution

Consistent Economic Valuation



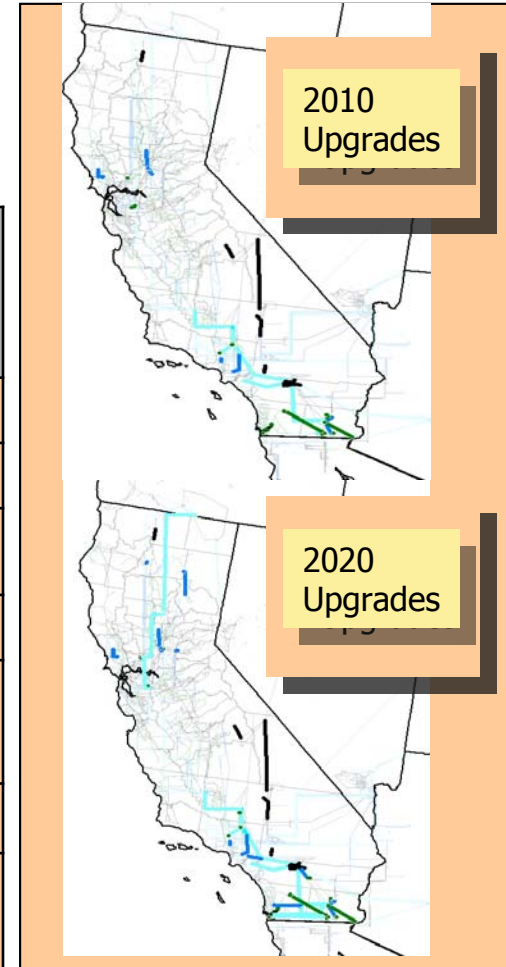


Cost Projections for Expansions

*** Order of magnitude estimates based on N-1 contingency, lines greater than 230kV**

*** Transmission plans and additions based on combination of utility projects and IAP team assessed needs**

Line Voltage	2010 Line Segments	2020 Line Segments	2010 Transformers	2020 Transformers
500	8	22	2	9
230	8	38	6	18
161/138	0	2	1	0
115	49	49	9	5
Below 110	13	17	14	8
Total #	78	128	32	40
Estimated Cost*	\$1.3 Bil	\$5.7 Bil	\$161 Mil	\$655 Mil



Capturing Other Renewable Benefits



<i>* Based on 2020 IAP Scenario</i>	In-State (CA)	WECC
NOx reduction	520 tons	4,000 tons
SOx reduction	700 tons	2,000 tons
CO2 reduction	~ 8 Mil tons	~ 23 Mil tons
Natural Gas Reduction	140 Bil ft ³ /yr	390 Bil ft ³ /yr

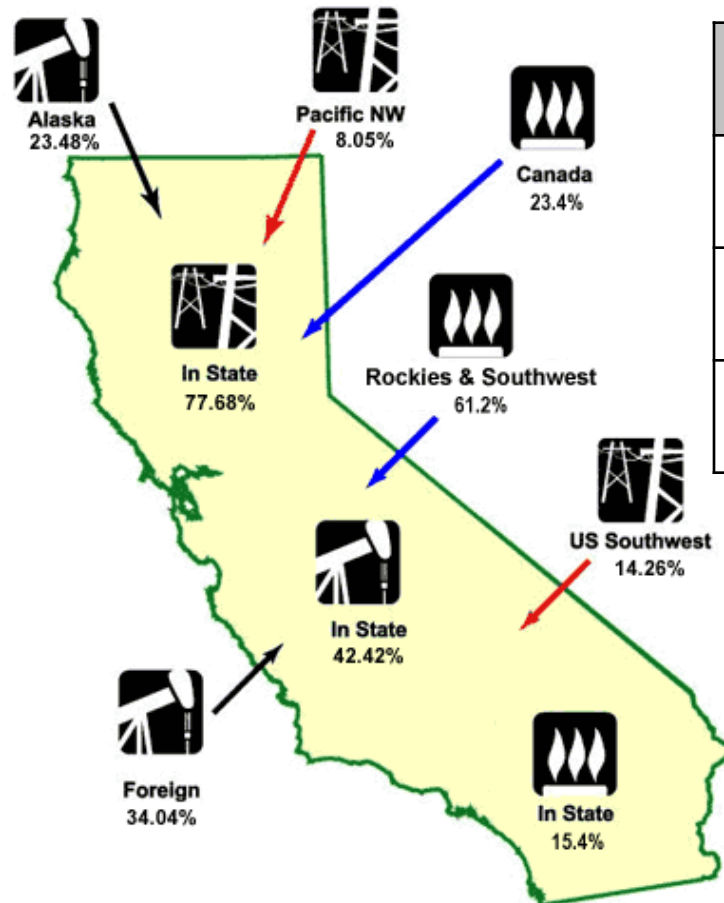


Continuing to Quantify Public Benefits

- Methodology to evaluate technical and economic impact of renewable resources on transmission grid
- Continue to partner with industry to gather appropriate data to monitor, trend and consider system change impacts
- Refined technical potential for renewables incorporating environmental and social aspects
 - Reduce
 - Pollution and emissions
 - Wildfires
 - Increase
 - Employment - economy
 - Education & training
 - Safety
 - Customer electricity choice
 - Generating resource diversification
 - Independence from fossil resources



Look Outside of Boundaries



CALIFORNIA'S ENERGY SOURCES

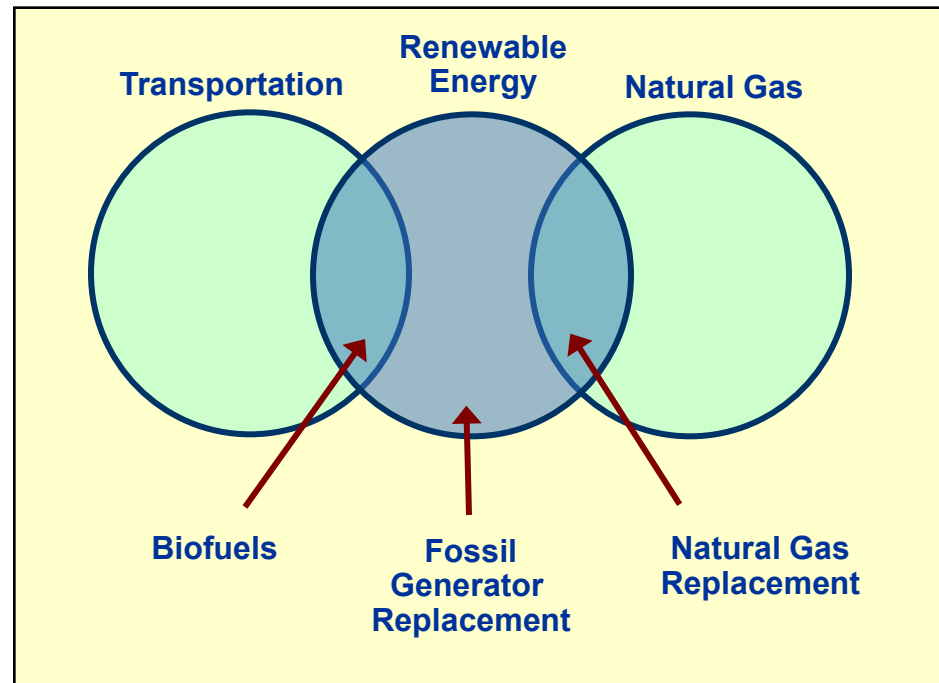
Forecasted Wind Potential

State	MW	GWh/year
Arizona	1,540	5,000
Nevada	17,000	55,000
Oregon	21,600	70,000

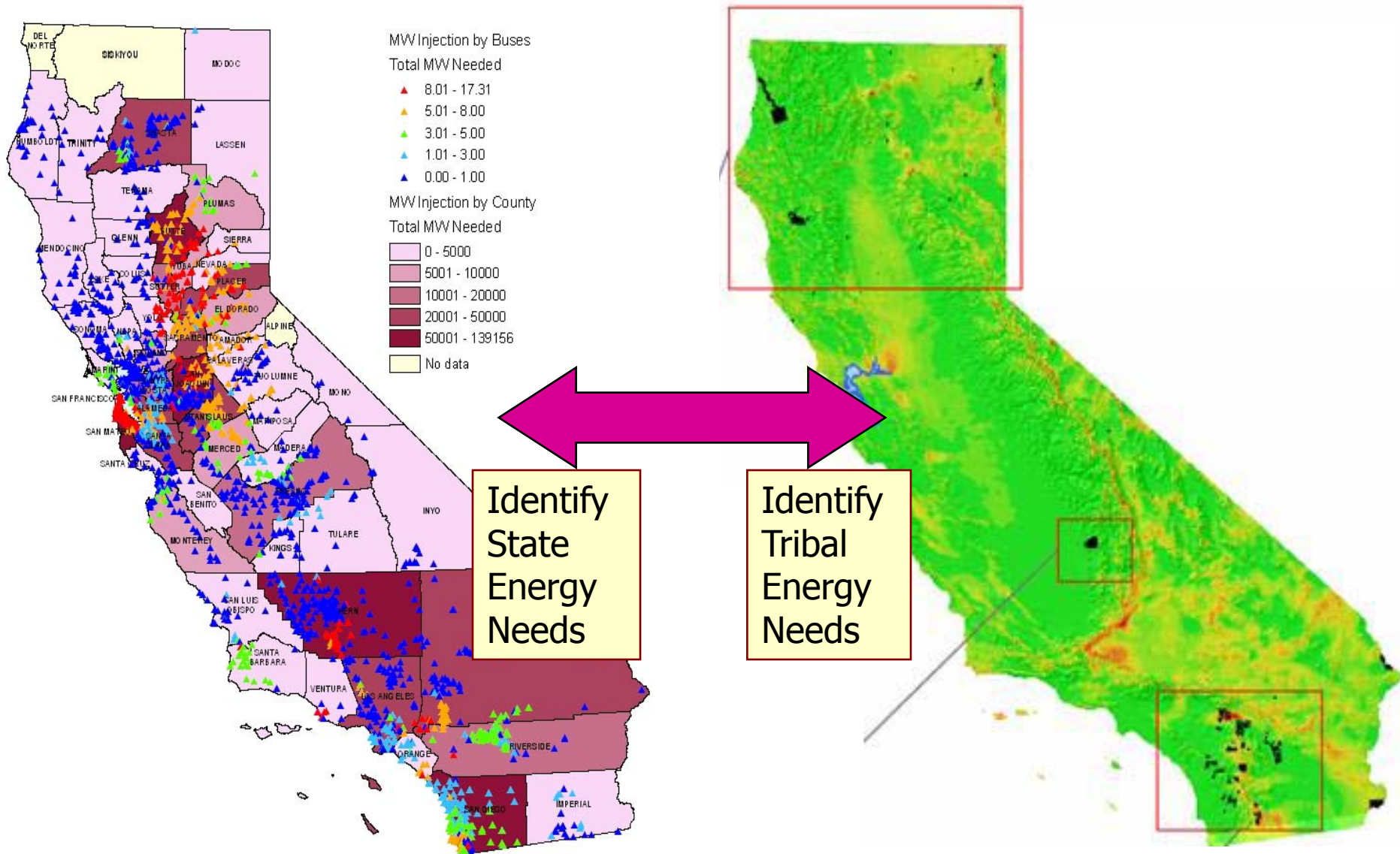
Law of Unintended Consequences



- Planning needs to consider the “law of unintended consequences”
 - Operational Impact due to replacing existing generators with renewables
 - Climate & Ecological change
 - Land Use
 - Water Use
 - Industry Shift



Meeting Common Needs





Points to Share: Finding A Common Interest

- Common forum to communicate very complex issues
 - Involve all interested stakeholders in the big picture planning and analysis process (takes multi-disciplines to maximize broad resource base)
 - Help communicate and educate on the “Cans” and “Cannots” sticking with the facts – busting myths and rumors can take a long time
 - Educate the next generation
- Leveraging lessons learned from others but need to temper and tailor to ones OWN market, regulatory and infrastructure environment
- Remained technology neutral and assess a portfolio of resources
 - Understand cost-benefit tradeoffs but assess needs for the benefit of the entire state
 - Have options
- Ensured system reliability and sustainability for the long haul !!
!!!
 - Band-aid fixes are costing more money and make the system less flexible to change and sometimes more vulnerable
 - Re-evaluate and re-assess timely to stay ahead of transforming technology and demand
- Stay informed – BE PART OF THE SOLUTION



Additional Information

California Energy Commission Web Sites:

- Renewable Energy Program www.energy.ca.gov/renewables/index.html
 - Information on consumer education, emerging and existing renewable, new renewable & incentive programs
http://www.energy.ca.gov/renewables/consumer_education/index.html
 - Call Center e-mail: Renewable@energy.state.ca.us
 - Call Center Phone: (800) 555-7794
 - California's Consumer Energy Center www.consumerenergycenter.org
 - Renewable Energy Program's *Overall Program Guidebook* and *Renewables Portfolio Standard Eligibility Guidebook* located at:
<http://www.energy.ca.gov/renewables/documents/index.html>
 - The Western Renewable Energy Generation Information System (WREGIS), a renewable energy registry and tracking system for the Western Interconnection
<http://www.energy.ca.gov/portfolio/wregis/index.html>
- Public Interest Energy Research (PIER) www.energy.ca.gov/pier/
 - Commission Cartography Office for details about ordering printed versions of maps by calling 916-654-3902, <http://www.energy.ca.gov/maps/wind.html>
 - Technology and resource reports: various links on Commission website for wind, geothermal, solar (CSP & PV), hydro and biomass



California Public Utilities Commission Web Site:

- Renewables Portfolio Standard
www.cpuc.ca.gov/PUC/energy/electric/renewableenergy/index.htm



Thank you

Questions/Comments??

Contact Info:

PIER R&D Wind & Renewable Integration

Dora Yen-Nakafuji
dyen@energy.state.ca.us

Renewable Energy Program

Kate Zocchetti
kzocchet@energy.state.ca.us